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ABSTRACT

This guide is designed to help education and training facilities develop and administer competency-based training programs to qualify and certify trainees in accordance with the American Welding Society (AWS) requirements for level II (advanced) welders. Presented first are the scope, objectives, and requirements of the AWS qualification/certification program. Listed next are the minimum training and qualification requirements expected of advanced welders in the following areas: basic skills; shielded metal arc welding (SMAW); gas metal arc welding (GMAW); flux cored arc welding (FCAW); gas tungsten arc welding (GTAW); oxyfuel gas cutting, air carbon arc cutting, and plasma arc cutting. Section 3 consists of curriculum guidelines for the courses required to meet the minimum training/qualification requirements, a competency-based program outline, and learning modules that include the following: learning objective, performance conditions, desired behavior, evaluation criteria, and learning activities. Section 4 consists of general guidelines and performance qualifications for achieving the optional qualification of AWS-certified welder by demonstrating competency in SMAW, GMAW, FCAW, and GTAW. Seventeen figures are included. Appended are the following: recommendations for support personnel and systems, trainee populations, facility planning, and personal and shop materials/equipment/tools; sample training achievement record; sample level II welder certificate of completion; and 57 references. (MN)

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ED 401 425

Guide for the Training and Qualification of Welding Personnel

Level II – Advanced Welder

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American Welding Society

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Guide for the Training and Qualification of Welding Personnel

Level II – Advanced Welders

Funded by
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Prepared by
AWS Education Department

Under the Direction of
AWS Education Grant Committee

Approved by
AWS Board of Directors

Abstract

This guide contains information to assist education and training facilities in the development and administration of competency-based training that leads to the qualification and certification of trainees in accordance with the requirements of AWS QC11, *Specification for the Qualification and Certification for Level II – Advanced Welders*. Included are sections on curriculum and qualification guidelines, as well as recommendations for facility planning, materials, equipment, and tools.

American Welding Society

550 N. W. LeJeune Road, Miami, Florida 33126

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A special note of appreciation is extended to each member of the American Welding Society who participated in the original industrial survey that helped identify the skill requirements for the Level II – Advanced Welder.

Foreword

(This Foreword is not a part of EG3.0–96, *Guide for the Training and Qualification of Welding Personnel Level II – Advanced Welder*, but is included for information purposes only.)

The American Welding Society (AWS), recognizing the need for competent welders, through a grant by the U. S. Department of Education (DOEd), formed the Education Grant Committee and assigned them the task of preparing this guide.

Welding has become a very sophisticated and technical science, requiring not only mental application but also hands-on abilities. The future need for competent welders should prompt the establishment of a greater number of educational programs. Thus, it becomes imperative that the training given be of a quality and quantity that adequately prepares trainees for industrial assignments at various levels of skill development well into the next century. To this end Level II – Advanced Welders come to the workforce possessing a prerequisite amount of knowledge, attitudes, skills and habits required to perform proceduralized tasks under general supervision, and complex tasks involving the use of theoretical knowledge and motor skills under close supervision.

As the name implies, it is the intent of this document to serve as a *Guide* for those wishing to establish, expand, or enhance a private or public training program for Level II – Advanced Welders. The basic requirements contained in this document are established as a result of individuals from a broad range of businesses, job classifications and industrial or educational areas participating in a national survey to identify welder skills. In conjunction with industry's response and the AWS Education Grant Committee's consensus, this document establishes the minimum requirements necessary to standardize the training and qualification of Level II – Advanced Welders throughout the United States of America. Members of the AWS community and the Education Grant Committee have a growing interest in positively promoting welder training and providing minimum standards for it's delivery.

The American Welding Society welcomes comments on this publication, and communications should be addressed to: The American Welding Society, Attention: Director of Education, 550 N. W. LeJeune Road, Miami, Florida, 33126.

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1. General

1.1 Scope. This guide establishes a minimum skill standard defining training and qualification requirements that are necessary for Participating Organizations to develop and administer a Level II – Advanced Welder Program in accordance with AWS QC11, *Specification for the Qualification and Certification for Level II – Advanced Welders*. This Guide is intended to specify a credible path for post-secondary or employer-based training facilities to build new programs and/or enhance existing programs to administer Level II – Advanced Welder training and qualification. Use of this guide is voluntary. Participating Organizations desiring to certify a trainee as an AWS Certified Level II – Advanced Welder shall consider the training and qualification guidelines within this document as mandatory requirements under the requirements of AWS QC11. Further, Participating Organizations may elect to use, or become, AWS Accredited Test Facilities under the requirements of AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program* and qualify advanced welders according to the requirements of AWS QC7, *Standard for AWS Certified Welders*.

1.2 Objectives

1.2.1 Provide training facilities with an industrial awareness of the occupational description, conditions, task listing, and profile that encompasses the job classification of Level II – Advanced Welder.

1.2.2 Establish a broad competency-based curriculum detailing the minimum acceptable skill requirements for the training and qualification of advanced welders.

1.2.3 Provide training facilities participating in the certification of advanced welders with a list of learning objectives and learning activities necessary to accomplish Level II – Advanced Welder training.

1.2.4 Provide training facilities participating in the certification of advanced welders with the references needed to compare existing or new curriculum with the AWS documents specified in this guide.

1.2.5 Provide training facilities participating in the certification of advanced welders with information related to the administration of Level II – Advanced Welder, written examination, workmanship qualification testing, and performance qualification testing.

1.2.6 Provide training facilities participating in the certification of advanced welders with information related to optional AWS QC11, *Level II – Advanced Welder Program* requirements for performance qualification tests administered at an AWS QC4, *Accredited Test Facility* through the AWS QC7, *Certified Welder Program*.

1.3 Requirements

1.3.1 Unless the secondary, post-secondary or employer-based training facility elects to become a Participating Organization under the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*, use of this document is voluntary.

1.3.2 Participating Organizations shall meet the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

1.3.3 Participating Organizations shall ensure that existing or new training materials are in compliance with the AWS documents specified in section 3, *Curriculum Guidelines* of this guide.

1.3.4 Participating Organizations shall administer a written safety examination prior to trainee performance of tasks in the work area or laboratory, in accordance with the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

1.3.5 Participating Organizations shall administer workmanship qualification testing at the end of training for each applicable welding or cutting process in accordance with the requirements of AWS QC 11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

1.3.6 Participating Organizations shall provide a means for trainees to take a closed book written examination based on the applicable subject matter identified in section 3, *Curriculum Guidelines* of this guide.

1.3.7 Trainees desiring entrance into the AWS Level II – Advanced Welder Certification program shall possess the necessary documentation of training, or demonstrate the ability to pass workmanship qualifications, written examination and performance qualifications in accordance with the requirements of AWS QC10, *Specification for Qualification and Certification for Entry Level Welders*.

1.3.8 Trainees desiring AWS Level II – Advanced Welder Certification shall pass workmanship qualification tests in accordance with the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

1.3.9 Trainees desiring AWS Level II – Advanced Welder Certification shall pass a closed book written welding fundamentals examination and a written open book welding specifications examination based on the applicable subject matter identified in section 3, *Curriculum Guidelines* of this guide.

1.3.10 Trainees failing the AWS Level II – Advanced Welder Certification written examination shall retest on all portions of the exam until competency is achieved in accordance with the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*. This requirement however, shall not supersede the authority of the local training evaluation criteria as established in the facility's guidelines.

1.3.11 Trainees desiring AWS Level II – Advanced Welder Certification shall pass a performance qualification test in accordance with the requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

1.3.12 Optional welder performance qualification tests for Level II – Advanced Welders shall conform to the requirements of AWS QC 11, *Specification for Qualification and Certification for Level II – Advanced Welders*, for welder performance tests administered at an AWS QC4, *Accredited Test Facility* using the AWS QC7, *Certified Welder Program*. (Refer to section 4 of this guide.)

1.3.13 Participating Organizations shall keep training records reflecting the results of Level II – Advanced Welder training, workmanship qualification, written examination, performance qualification, and as applicable optional AWS QC7 welder performance qualification tests.

2. Industrial Awareness

2.1 Scope. Training facilities must understand the needs of industry and provide programs that prepare students to fill these needs. To establish a successful program for welder training, the first step would be to understand the job functions of this person in industry. This is difficult because of the highly diverse nature of these functions and the fact that they vary from industry to industry and from company to company. Recognizing this diversity, AWS conducted an industry-wide survey, covering a broad base of businesses, job classifications, and educational institutions, to gather and analyze information pertinent to the skills a Level II – Advanced Welder should possess. From a needs assessment and analysis a profile of the Level II – Advanced Welder was developed (refer to Figure 1). The profile identifies skill and knowledge areas common to all advanced welders, regardless of their unique situation in industry. To assist institutions in increasing their awareness of industry's needs, the following sections include portions of the occupational data collected during the needs assessment and analysis phase of this project.

2.2 Level II – Advanced Welder Definition. An individual employed in this position is considered to possess a prerequisite amount of knowledge, attitude, skills and habits required to perform proceduralized tasks under general supervision, and complex tasks involving the use of theoretical knowledge and motor skills under close supervision.

2.3 Level II – Advanced Welder Occupational Description. The position is comprised of the following areas:

2.3.1 Prerequisite Knowledge and Skills. Possesses the requisite knowledge and skill levels of an entry level welder as defined by AWS QC10, *Specification for Qualification and Certification for Entry Level Welders* and detailed in AWS EG2.0, *Guide for the Training and Qualification of Welding Personnel, Entry Level Welder.*

2.3.2 Layout/Fitup Practices. Possesses the prerequisite drawing and welding symbol interpretation skills of an entry level welder. Demonstrates a fundamental knowledge of layout and fitup principles. Shows the ability to operate shop equipment safely and use layout tools for geometric construction. Has a fundamental understanding of advanced measurement practices, design for welding and the use of fixtures and positioners. Works from drawings or sketches to prepare, form or cut multiple parts and assemble simple weldments. Recognizes welded joint and welding requirements based on welding symbol information.

2.3.3 Arc Welding. Possesses the prerequisite arc welding skills of an entry level welder. Has a fundamental understanding of welding metallurgy including mechanical and chemical properties of metals, weld zone metallurgy, residual stress and control of distortion. Demonstrates knowledge of joint design and preparation, selection of materials, arc welding application, weld quality and weld repairs (corrective actions). Sets up shielded metal arc welding operations, for all position fillet and groove welding on an unlimited thickness range of carbon steel plate and pipe, and a limited thickness range of stainless steel plate. Sets up gas metal arc welding (short circuit transfer) operations, for all position fillet and groove welding on a limited thickness range of carbon steel plate, and limited position fillet and groove welding on pipe. Sets up gas metal arc welding (spray transfer) operations, for a limited position, unlimited thickness range of carbon steel plate, limited position fillet welding on pipe, and all positions fillet and groove welding a limited thickness range of aluminum plate. Sets up flux cored arc welding operations, for all position fillet and groove welding on an unlimited thickness range of carbon steel plate, and limited position fillet and groove welding on carbon steel pipe. Sets up gas tungsten arc welding operations, for all position fillet and groove welding within a limited thickness range of carbon steel, stainless steel and aluminum sheet metals. Sets up gas tungsten arc welding operations, for limited position, limited thickness fillet and groove welding of carbon steel, stainless steel and aluminum pipe or tubing. Performs minor external repairs to equipment and accessories.

2.3.4 Oxyfuel Gas Cutting. Possesses the prerequisite oxyfuel gas cutting skills of an entry level welder. Sets up and performs manual oxyfuel gas cutting operations that include straight and shape cutting, beveling, and weld removal (weld washing) for various product forms including plate and pipe. Sets up and operates machine oxyfuel gas cutting equipment (track burner) to perform straight cutting and beveling operations. Demonstrates knowledge of preparation and selection of materials, cutting applications, cut quality and cut surface repairs (corrective actions). Performs minor external repairs to equipment and accessories.

2.3.5 Arc Cutting and Gouging. Possesses the prerequisite arc cutting skills of an entry level welder. Sets up and performs manual air carbon arc cutting operations that include gouging, beveling, and weld removal on various product forms including plate and pipe. Sets up and performs manual plasma arc cutting operations that include straight cutting, shape cutting, and beveling, on various product forms including plate and pipe. Sets up and operates machine plasma arc cutting equipment (track burner) to perform straight cutting and beveling operations. Demonstrates knowledge of preparation and selection of materials, arc cutting applications, cut quality and cut surface repairs (corrective actions). Performs minor external repairs to equipment and accessories.

2.3.6 Welding Codes and Standards. Possesses a fundamental understanding of code/standard interpretation.

2.3.7 Qualification and Certification. Recognizes the functions of qualification and certification, has a fundamental understanding of procedure specifications, procedure qualifications, welding procedures and performance qualification.

2.3.8 Inspection and Testing. Possesses the prerequisite inspection skills of an entry level welder. Visually examines all personal welding and cutting assignments for unfavorable weld and cut edge surface discontinuities. Takes corrective actions to repair unfavorable weld and cut edge surface discontinuities, before final inspection by a supervisor. Has a fundamental understanding of destructive/non-destructive testing principles and weld testing interpretation.

2.4 Level II – Advanced Welder Occupational Conditions.

2.4.1 Work Environment. Advanced welders are employed in a wide range of industries that use welding and welding-related tasks during the course of daily operations. This range of industries includes small, medium, and large union or non-union facilities.

2.4.2 Occupational Hazards. As is the case in most metalworking industries, the potential for bodily harm and hazardous situations exists. High electrical currents and voltages are used to operate machinery and welding equipment. Machinery for shearing, forming, and punching various thicknesses of materials is used. Flammable and other compressed gases are used during flame cutting and welding operations. The employee may be in direct contact with heavy sections during lifting and positioning operations. Welders may work in enclosed, restricted spaces, and at times at high elevations and in awkward positions. An undesirable noise level is sometimes generated during the production process. The welder must take safety precautions, and be safety conscious at all times.

2.4.3 Worker Profile. This position involves concentration, decision making, and physical tasks.

2.4.3.1 Physical Requirements. Advanced welders must meet the physical requirements established by the employer.

2.4.3.2 Employability. Advanced welders should exhibit good written, oral, and listening skills, in addition to competency in problem solving and decision making. These individuals should display good judgement, dependability and interact well with people.

2.4.3.3 Education. Level II – Advanced Welder training may be accomplished through postsecondary, vocational-technical schools, junior colleges, universities, apprenticeship or employer-based welder training programs. Sufficient workplace skills (i.e. foundation skills such as: reading, writing, math, science, communication skills, adaptability skills and employability skills) are required to complete requisite welding related knowledge and skills training.

Entry Level Welder skills achieved and substantiated through training/testing or testing alone in accordance with AWS QC10, *Specification for Qualification and Certification for Entry Level Welders* and detailed in AWS EG2.0, *Guide for the Training and Qualification of Welding Personnel, Entry Level Welder,* are a prerequisite to Level II – Advanced Welder training.

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

BASIC SKILLS AND KNOWLEDGE

READING
WRITING
COMMUNICATION

- *ENTRY LEVEL WELDER REQUIREMENTS

MATHEMATICS

- *ENTRY LEVEL WELDER REQUIREMENTS
- **PREPARE PARTS AND ASSEMBLE COMPONENTS USING THE PRINCIPLES OF TRIGONOMETRY
- **READ AND USE U. S. (CUSTOMARY)/SI (METRIC) PRECISION MEASURING INSTRUMENTS

*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM

**RECOMMEND ASSESSMENT AND TESTING PRIOR TO EXITING ADVANCED WELDER TRAINING

****EMPLOYABILITY SKILLS**

- EMPLOYMENT PREPARATION
  - GETTING A JOB
  - BENEFITS AND OBLIGATIONS OF BEING EMPLOYED
  - MEETING THE REQUIREMENTS OF AN EMPLOYER'S RULES & STANDARDS
  - WRITING RESUMES'
  - COMPLETING APPLICATIONS
  - CONTACTING PROSPECTIVE EMPLOYERS
  - PARTICIPATING IN AN EMPLOYMENT INTERVIEW
  - WRITING FOLLOW-UP LETTERS
- WORK-MATURITY SKILLS
  - PERSONAL RESPONSIBILITY SKILLS
  - GROOMING AND HYGIENE
  - FOLLOWING DIRECTIONS
  - PERSONAL BEHAVIOR
  - WILLINGNESS TO WORK
  - TRUTHFULNESS
  - PERSONALITY
- WORK HABITS
  - ATTENDANCE - BEING ON THE JOB REGULARLY AND PROMPTLY
  - RECORD TIMELY NOTICE IF LATE OR ABSENT
  - COMPLETE TASKS ON TIME
  - DEMONSTRATE RESPONSIBILITY AND DEPENDABILITY BY CARRYING OUT ASSIGNED TASKS
  - PREPARE AND ORGANIZE JOB RESPONSIBILITIES
  - ARRANGE MATERIALS, TOOLS AND WORKSTATIONS
  - DEMONSTRATE CONSISTENCY IN TASK COMPLETION
  - USE APPROPRIATE JOB TECHNIQUES
  - PLAN TIME EFFECTIVELY
  - PLAN REASONABLE WORK GOALS
- RECOGNIZING EMPLOYER EXPECTATIONS
- RECOGNIZING SUPERVISOR EXPECTATIONS
- PERSONAL EMPLOYMENT EXPECTATIONS

**RECOMMEND ASSESSMENT AND TESTING PRIOR TO EXITING ADVANCED WELDER TRAINING

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Figure 1 – Level II – Advanced Welder Profile. This information was developed as a result of a needs assessment and analysis from a national survey distributed to a mailing list obtained from the roles of AWS membership.

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

RELATED SKILLS AND KNOWLEDGE

SAFE PRACTICES	GENERAL SAFETY PROTECTION OF PERSONNEL PROTECTION OF THE WORK AREA VENTILATION FIRE PREVENTION AND PROTECTION CONFINED SPACES PRECAUTIONARY LABELING	MANDATORY SAFETY PRETEST AND MANDATORY SAFETY POST-TEST
COMMON WORK ASSIGNMENTS *ELECTRICAL FUNDAMENTALS *DRAWING/WELDING SYMBOL INTERPRETATION	*ENTRY LEVEL WELDER REQUIREMENTS	*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM **PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION
LAYOUT AND FITUP	**LAYOUT/FITUP PRINCIPLES AND PRACTICES SAFE OPERATING PRACTICES INTRODUCTION TO SHOP EQUIPMENT LAYOUT TOOLS FOR GEOMETRIC CONSTRUCTION ADVANCED MEASUREMENT PRACTICES DESIGN FOR WELDING FIXTURES AND POSITIONERS PART PREPARATIONS - CUTTING AND FORMING FABRICATE SIMPLE WELDMENTS	
WELDING CODES & STANDARDS	*ENTRY LEVEL WELDER REQUIREMENTS **INTRODUCTION TO CODE/STANDARD INTERPRETATION	
QUALIFICATION & CERTIFICATION	**INTRODUCTION TO QUALIFICATION AND CERTIFICATION PROCEDURE SPECIFICATIONS AND QUALIFICATION WELDING PROCEDURES PERFORMANCE QUALIFICATION	
WELDING INSPECTION AND TESTING	*ENTRY LEVEL WELDER REQUIREMENTS **NON-DESTRUCTIVE TESTING PRINCIPLES **DESTRUCTIVE TESTING PRINCIPLES **WELD TESTING INTERPRETATION	

Figure 1 – Level II – Advanced Welder Profile (continued).

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LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

ARC WELDING PROCESSES and RELATED KNOWLEDGE

SHIELDED METAL ARC WELDING [SMAW] - PLAIN CARBON STEEL, STAINLESS STEEL

- **SAFE PRACTICES**
  - SAFE OPERATING PRACTICES
  - — MANDATORY SAFETY POST-TEST

- **WELDING THEORY**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - **JOINT DESIGN AND PREPARATION
  - **MATERIALS
  - **APPLICATIONS
  - **WELD QUALITY AND REPAIRS (CORRECTIVE ACTIONS)
- **WELDABILITY**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - **INTRODUCTION TO WELDING METALLURGY
  - **MECHANICAL AND CHEMICAL PROPERTIES OF METALS
  - **WELD ZONE METALLURGY
  - **RESIDUAL STRESS AND DISTORTION
- **WELDING TERMS and DEFINITIONS**
  - **RECALL/RELATE WELDING INFORMATION
  - **COMMUNICATE WELDING INFORMATION

(Welding Theory, Weldability, Welding Terms and Definitions:)

*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM

**PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION

- **WELDER PERFORMANCE**
  - *ENTRY LEVEL WELDER PERFORMANCE REQUIREMENTS
  - STAINLESS STEEL
    - FILLET WELD (PLATE)
      - 1F - FLAT
      - 2F - HORIZONTAL
      - 3F - VERTICAL
      - 4F - OVERHEAD
    - GROOVE WELD (PLATE)
      - 1G - FLAT
      - 2G - HORIZONTAL
      - 3G - VERTICAL
      - 4G - OVERHEAD
  - CARBON STEEL
    - FILLET WELD (PIPE)
      - 1F - FLAT
      - 2F - HORIZONTAL
      - 4F - OVERHEAD
      - 5F - MULTIPLE
      - 6F - MULTIPLE
    - GROOVE WELD (PIPE)
      - 2G - HORIZONTAL
      - 5G - VERTICAL
      - 6G - OVERHEAD

VISUAL EXAMINATION (ALL)

WORKMANSHIP QUALIFICATION ALL POSITIONS - STAINLESS FILLER TO CARBON STEEL - PLATE (OPTIONAL - STAINLESS FILLER TO STAINLESS STEEL - PLATE)

PERFORMANCE QUALIFICATION 6G - CARBON STEEL - PIPE

OPTIONAL CODE QUALIFICATION AWS QC7 PROGRAM
3G, 4G - STAINLESS STEEL - PLATE
6G - CARBON STEEL - PIPE

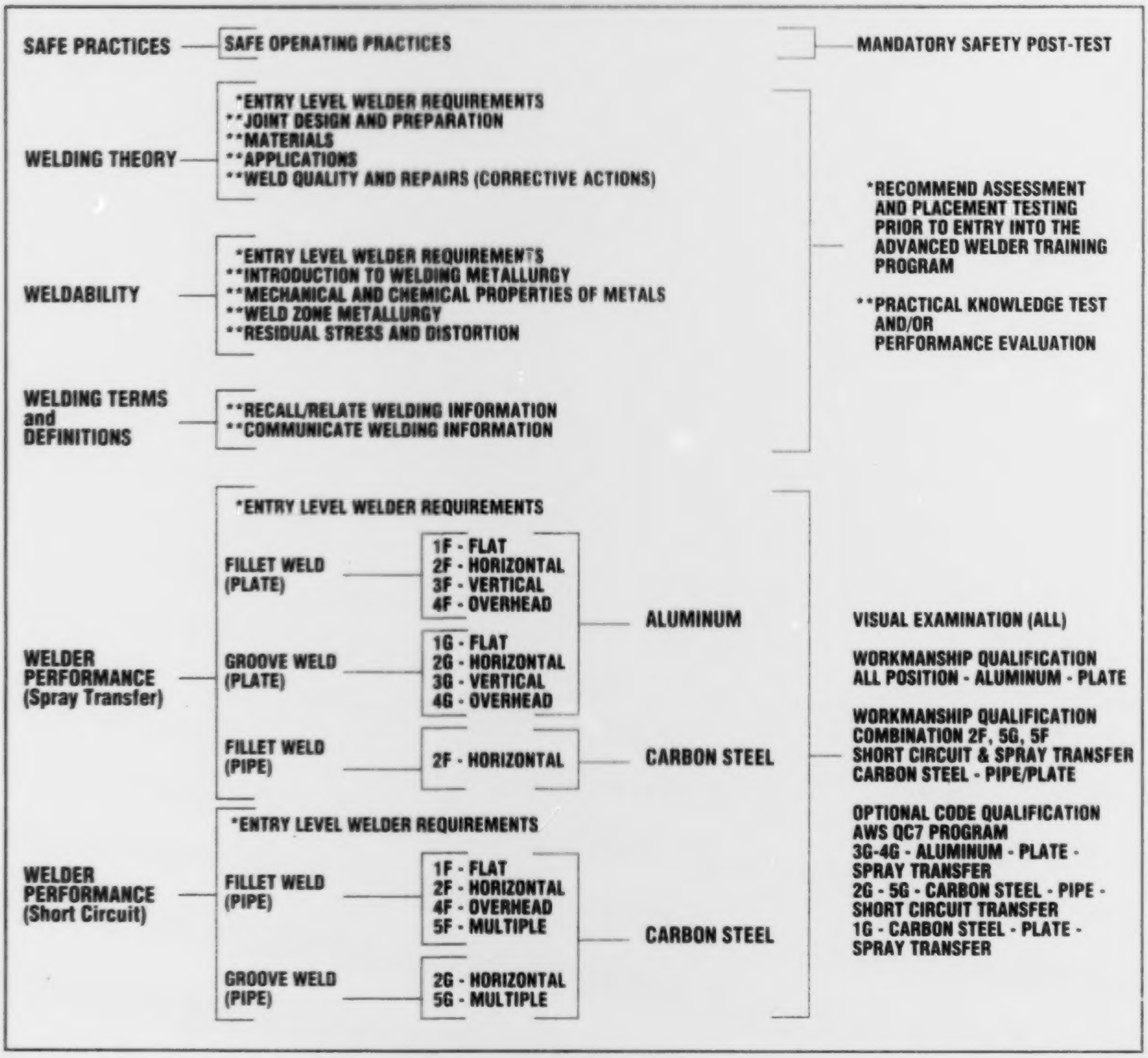
Figure 1 – Level II – Advanced Welder Profile (continued).

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

ARC WELDING PROCESSES and RELATED KNOWLEDGE

GAS METAL ARC WELDING [GMAW & GMAW-S] - PLAIN CARBON STEEL, ALUMINUM



- **SAFE PRACTICES**
  - SAFE OPERATING PRACTICES
  - — MANDATORY SAFETY POST-TEST
- **WELDING THEORY**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - **JOINT DESIGN AND PREPARATION
  - **MATERIALS
  - **APPLICATIONS
  - **WELD QUALITY AND REPAIRS (CORRECTIVE ACTIONS)
- **WELDABILITY**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - **INTRODUCTION TO WELDING METALLURGY
  - **MECHANICAL AND CHEMICAL PROPERTIES OF METALS
  - **WELD ZONE METALLURGY
  - **RESIDUAL STRESS AND DISTORTION
- **WELDING TERMS and DEFINITIONS**
  - **RECALL/RELATE WELDING INFORMATION
  - **COMMUNICATE WELDING INFORMATION

(Welding Theory, Weldability, Welding Terms and Definitions:)

*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM

**PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION

- **WELDER PERFORMANCE (Spray Transfer)**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - FILLET WELD (PLATE)
    - 1F - FLAT
    - 2F - HORIZONTAL
    - 3F - VERTICAL
    - 4F - OVERHEAD
  - GROOVE WELD (PLATE)
    - 1G - FLAT
    - 2G - HORIZONTAL
    - 3G - VERTICAL
    - 4G - OVERHEAD
  - — ALUMINUM
  - FILLET WELD (PIPE)
    - 2F - HORIZONTAL
  - — CARBON STEEL
- **WELDER PERFORMANCE (Short Circuit)**
  - *ENTRY LEVEL WELDER REQUIREMENTS
  - FILLET WELD (PIPE)
    - 1F - FLAT
    - 2F - HORIZONTAL
    - 4F - OVERHEAD
    - 5F - MULTIPLE
  - GROOVE WELD (PIPE)
    - 2G - HORIZONTAL
    - 5G - MULTIPLE
  - — CARBON STEEL

(Welder Performance:)

VISUAL EXAMINATION (ALL)

WORKMANSHIP QUALIFICATION
ALL POSITION - ALUMINUM - PLATE

WORKMANSHIP QUALIFICATION
COMBINATION 2F, 5G, 5F
SHORT CIRCUIT & SPRAY TRANSFER
CARBON STEEL - PIPE/PLATE

OPTIONAL CODE QUALIFICATION
AWS QC7 PROGRAM
3G-4G - ALUMINUM - PLATE - SPRAY TRANSFER
2G - 5G - CARBON STEEL - PIPE - SHORT CIRCUIT TRANSFER
1G - CARBON STEEL - PLATE - SPRAY TRANSFER

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Figure 1 – Level II – Advanced Welder Profile (continued).

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

ARC WELDING PROCESSES and RELATED KNOWLEDGE

FLUX CORED ARC WELDING [FCAW & FCAW-G] - PLAIN CARBON STEEL

SAFE PRACTICES
- SAFE OPERATING PRACTICES
- MANDATORY SAFETY POST-TEST

WELDING THEORY
- *ENTRY LEVEL WELDER REQUIREMENTS
- **JOINT DESIGN AND PREPARATION
- **MATERIALS
- **APPLICATIONS
- **WELD QUALITY AND REPAIRS (CORRECTIVE ACTIONS)

WELDABILITY
- *ENTRY LEVEL WELDER REQUIREMENTS
- **INTRODUCTION TO WELDING METALLURGY
- **MECHANICAL AND CHEMICAL PROPERTIES OF METALS
- **WELD ZONE METALLURGY
- **RESIDUAL STRESS AND DISTORTION

WELDING TERMS and DEFINITIONS
- **RECALL/RELATE WELDING INFORMATION
- **COMMUNICATE WELDING INFORMATION

*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM

**PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION

WELDER PERFORMANCE (Self - Shielded) (Gas - Shielded)

*ENTRY LEVEL WELDER REQUIREMENTS

- FILLET WELD (PIPE)
  - 1F - FLAT
  - 2F - HORIZONTAL
  - 4F - OVERHEAD
  - 5F - MULTIPLE
- GROOVE WELD (PIPE)
  - 2G - HORIZONTAL
  - 5G - MULTIPLE
- CARBON STEEL

VISUAL EXAMINATION (ALL)

WORKMANSHIP QUALIFICATION
COMBINATION 5G-5F
SELF- AND GAS-SHIELDED
CARBON STEEL - PIPE/PLATE

OPTIONAL CODE QUALIFICATION
AWS QC7 PROGRAM
CARBON STEEL - PIPE
2G - 5G - SELF-SHIELDED
2G - 5G - GAS-SHIELDED

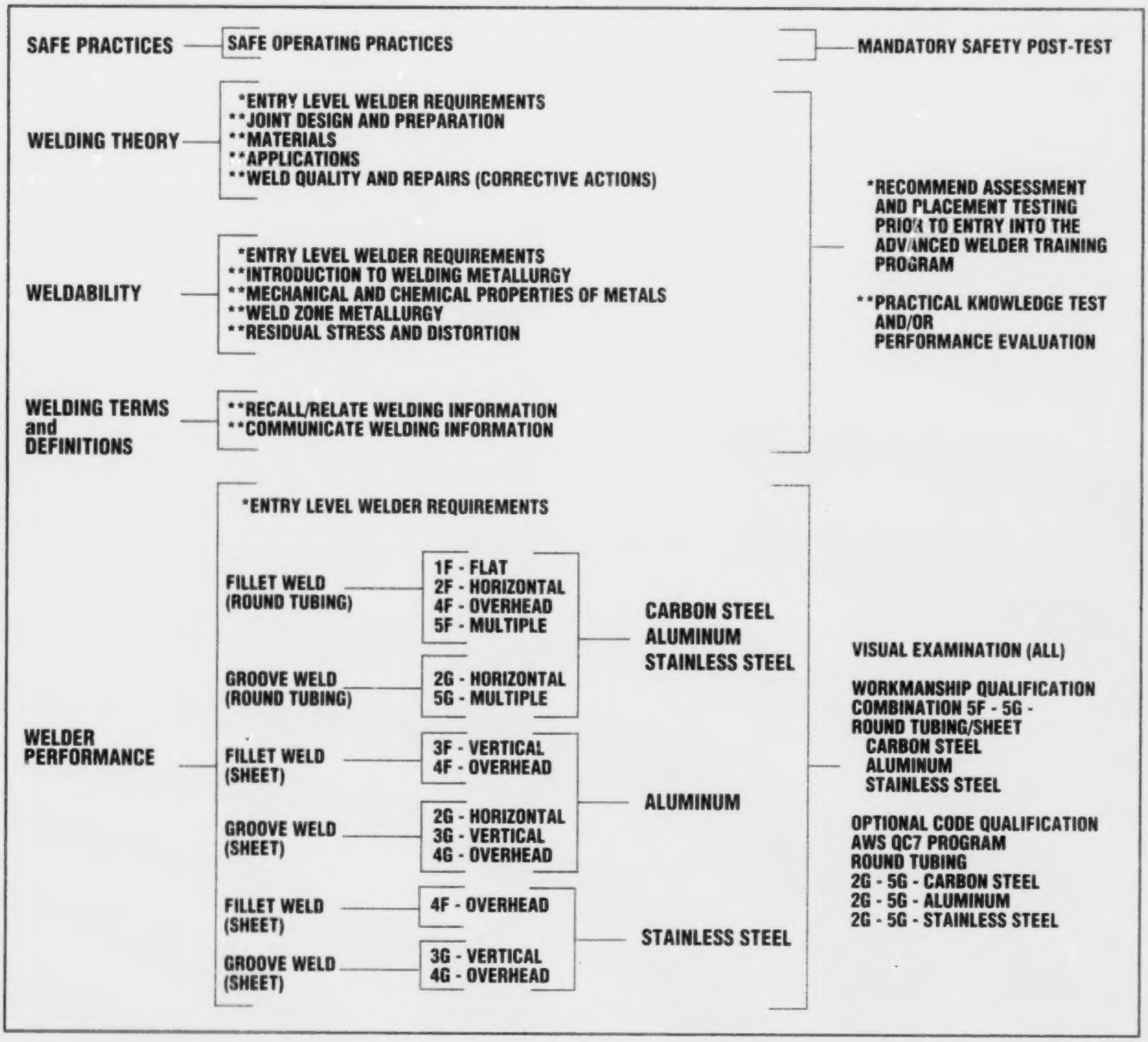
Figure 1 – Level II – Advanced Welder Profile (continued).

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

ARC WELDING PROCESSES and RELATED KNOWLEDGE

GAS TUNGSTEN ARC WELDING [GTAW] - PLAIN CARBON STEEL, ALUMINUM, STAINLESS STEEL



SAFE PRACTICES
- SAFE OPERATING PRACTICES

MANDATORY SAFETY POST-TEST

WELDING THEORY
- *ENTRY LEVEL WELDER REQUIREMENTS
- **JOINT DESIGN AND PREPARATION
- **MATERIALS
- **APPLICATIONS
- **WELD QUALITY AND REPAIRS (CORRECTIVE ACTIONS)

WELDABILITY
- *ENTRY LEVEL WELDER REQUIREMENTS
- **INTRODUCTION TO WELDING METALLURGY
- **MECHANICAL AND CHEMICAL PROPERTIES OF METALS
- **WELD ZONE METALLURGY
- **RESIDUAL STRESS AND DISTORTION

WELDING TERMS and DEFINITIONS
- **RECALL/RELATE WELDING INFORMATION
- **COMMUNICATE WELDING INFORMATION

*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM

**PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION

WELDER PERFORMANCE
- *ENTRY LEVEL WELDER REQUIREMENTS
- FILLET WELD (ROUND TUBING)
  - 1F - FLAT
  - 2F - HORIZONTAL
  - 4F - OVERHEAD
  - 5F - MULTIPLE
- GROOVE WELD (ROUND TUBING)
  - 2G - HORIZONTAL
  - 5G - MULTIPLE
- CARBON STEEL, ALUMINUM, STAINLESS STEEL
- FILLET WELD (SHEET)
  - 3F - VERTICAL
  - 4F - OVERHEAD
- GROOVE WELD (SHEET)
  - 2G - HORIZONTAL
  - 3G - VERTICAL
  - 4G - OVERHEAD
- ALUMINUM
- FILLET WELD (SHEET)
  - 4F - OVERHEAD
- GROOVE WELD (SHEET)
  - 3G - VERTICAL
  - 4G - OVERHEAD
- STAINLESS STEEL

VISUAL EXAMINATION (ALL)

WORKMANSHIP QUALIFICATION
COMBINATION 5F - 5G -
ROUND TUBING/SHEET
CARBON STEEL
ALUMINUM
STAINLESS STEEL

OPTIONAL CODE QUALIFICATION
AWS QC7 PROGRAM
ROUND TUBING
2G - 5G - CARBON STEEL
2G - 5G - ALUMINUM
2G - 5G - STAINLESS STEEL

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Figure 1 – Level II – Advanced Welder Profile (continued).

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

OXYFUEL GAS CUTTING PROCESSES and RELATED KNOWLEDGE

OXYFUEL GAS CUTTING [OFC] - PLAIN CARBON STEEL

SAFE PRACTICES	SAFE OPERATING PRACTICES HANDLING AND STORAGE OF COMPRESSED GASES		MANDATORY SAFETY POST-TEST
CUTTING THEORY	*ENTRY LEVEL WELDER REQUIREMENTS **PREPARATION **MATERIALS **APPLICATIONS **CUTTING QUALITY AND REPAIRS (CORRECTIVE ACTIONS)		*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM **PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION
CUTTING TERMS and DEFINITIONS	**RECALL/RELATE CUTTING INFORMATION **COMMUNICATE CUTTING INFORMATION		
WELDER PERFORMANCE (MANUAL)	*ENTRY LEVEL WELDER REQUIREMENTS STRAIGHT CUTTING BEVELING SHAPE CUTTING WELD REMOVAL (WELD WASHING)	PLATE and PIPE	VISUAL EXAMINATION PERFORMANCE EVALUATION
WELDER PERFORMANCE (MACHINE) [TRACK BURNER] [PIPE CUTTING EQUIPMENT]	*ENTRY LEVEL WELDER REQUIREMENTS STRAIGHT CUTTING BEVELING		

Figure 1 – Level II – Advanced Welder Profile (continued).

LEVEL II - ADVANCED WELDER PROFILE

[Minimum Training and Qualification Requirements]

ARC CUTTING PROCESSES and RELATED KNOWLEDGE

AIR CARBON ARC CUTTING [CAC-A] - PLAIN CARBON STEEL

SAFE PRACTICES	SAFE OPERATING PRACTICES HANDLING AND STORAGE OF COMPRESSED GASES		MANDATORY SAFETY POST-TEST
CUTTING THEORY	*ENTRY LEVEL WELDER REQUIREMENTS **PREPARATION **MATERIALS **APPLICATIONS **CUTTING QUALITY AND REPAIRS (CORRECTIVE ACTIONS)		*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM **PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION
CUTTING TERMS and DEFINITIONS	**RECALL/RELATE CUTTING INFORMATION **COMMUNICATE CUTTING INFORMATION		
WELDER PERFORMANCE (MANUAL)	*ENTRY LEVEL WELDER REQUIREMENTS	PLATE and PIPE	VISUAL EXAMINATION PERFORMANCE EVALUATION

PLASMA ARC CUTTING [PAC] - PLAIN CARBON STEEL, STAINLESS STEEL, ALUMINUM

SAFE PRACTICES	SAFE OPERATING PRACTICES HANDLING AND STORAGE OF COMPRESSED GASES		MANDATORY SAFETY POST-TEST
CUTTING THEORY	*ENTRY LEVEL WELDER REQUIREMENTS **PREPARATION **MATERIALS **APPLICATIONS **CUTTING QUALITY AND REPAIRS (CORRECTIVE ACTIONS)		*RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE ADVANCED WELDER TRAINING PROGRAM **PRACTICAL KNOWLEDGE TEST AND/OR PERFORMANCE EVALUATION
CUTTING TERMS and DEFINITIONS	**RECALL/RELATE CUTTING INFORMATION **COMMUNICATE CUTTING INFORMATION		
WELDER PERFORMANCE (MANUAL)	*ENTRY LEVEL WELDER REQUIREMENTS STRAIGHT CUTTING BEVELING SHAPE CUTTING GOUGING	PLATE and PIPE	VISUAL EXAMINATION PERFORMANCE EVALUATION
WELDER PERFORMANCE (MACHINE) [TRACK BURNER] [PIPE CUTTING EQUIPMENT]	*ENTRY LEVEL WELDER REQUIREMENTS STRAIGHT CUTTING BEVELING		

Figure 1 – Level II – Advanced Welder Profile (continued).

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3. Curriculum Guidelines

3.1 General Guidelines. It is the sole intent of this document to define a competency-based welding curriculum. The course structure of this curriculum is not sequenced for linear delivery (i.e. from course A to B, etc.). Therefore, it is the responsibility of the post-secondary or employer-based training program to establish any guidelines for the duration of training, prerequisites related to basic skills and sequencing of instructional activities. Training activities should consistently reinforce the use of basic skills (i.e. reading, writing, math and communications) and previously acquired entry level welder skills.

3.1.1 Preassessment. The welding industry wants advanced welders with strong reading, writing, mathematics, listening and oral communication, and employability skills that are closely related to job performance. The curriculum in this guide also requires sufficient basic skills to carry out and complete the training. Therefore, it is strongly recommended that prospective trainees undergo a preplacement assessment for basic skill competency prior to entry into the welding program. Further, the competency level for said skills should meet the Grade Level Content or GED Level for the applicable welder level, as defined by federal or state guidelines.

3.1.2 Curriculum Conventions. Terminology associated with the curriculum Guidelines is defined as follows:

Competency-Based Program Outline: The outline converts the *primary occupation* (i.e. Level II – Advanced Welder), *occupational specialties* (e.g. arc welding), *sub-specialties* (e.g. shielded metal arc welding) and *tasks* (e.g. Perform Safety Inspections of Equipment and Accessories) to a *program title* (i.e. Level II – Advanced Welder Training), *courses* (e.g. Course B: Arc Welding Principles and Practices), *units* (e.g. Unit #1: Shielded Metal Arc Welding) and *learning objectives* (e.g. Learning Objective #1: Perform safety inspection of equipment and accessories.) The outline assists in modularizing the training program.

Learning Objectives: A written statement cast in the future which defines the *conditions* under which learning will occur and the *criteria* for determining when the objective has been attained. The following elements comprise a learning objective:

Title: A phrase that specifies the activity. The title of a learning objective is the same as the title of the task from which it was derived.

Performance Conditions: A statement which defines the "givens" under which the trainee will perform the objective. In most instances, the conditions define the teaching methods, the equipment, tools materials and supplies given the trainee, and the learning environment where training takes place.

Desired Behavior: A statement, written in the future tense, specifying the activity to be performed.

Evaluation Criteria: A statement which establishes the standard against which the trainee's performance of the objective is measured. The basic elements of evaluation may contain a product statement (when the objective has been performed correctly), and if appropriate, a process statement, inspection, time limitations or repetitions of the objective performed by the trainee over a given period of time.

Learning Modules: A learning module establishes the basis for individualizing the learning objective of the training program. These modules identify and organize learning activities for a learning objective.

Learning Activities: An organizational concept that sequences training events in a systematic approach for guiding trainees to a defined objective. Learning activities consist of *knowledge-related* activities and *performance-related activities*. Knowledge-related learning activities are divided into two types: *knowledge acquisition* – sources of information which provide the knowledge needed to perform the learning activity; and *information review* and *testing* (formative testing) activities which guide the instructor in reviewing and assessing the trainee's performance of the learning objective. Knowledge-related learning activities are brought to a close with the trainee's successful completion of a related information test (formative testing). Performance-related learning activities provide the instructor with a means by which to guide the trainee in attaining the objective. Utilizing the now–acquired technical information to guide his or her actions, the trainee receives a *demonstration* of the objective, *practices* performing it until an acceptable level of skill and confidence is gained, and takes a *performance test* (i.e. workmanship qualifications) of the same to confirm mastery of the objective. Other performance-related activities may be included in the basic sequence, but the demonstration–practice–performance trilogy is fundamental to ordering performance-related activities.

Workmanship Qualification: A practical application test with elements that include drawing interpretation, fabrication, and welding symbol interpretation. The test is evaluated in three stages and each stage must be completed correctly before moving to the next. The first stage is the preparation of a bill of materials in U. S. customary units of measure, then conversion of those units of measure to SI metric units. The first stage measures drawing interpretation and basic math skills. Upon successful completion of stage one, the trainee fabricates and assembles the weldment. The second stage measures fabrication skills. Upon successful completion of the second stage, the trainee welds the assembly according to welding symbol information. The final stage measures a trainee's ability to interpret welding symbol information and use of manipulative skills. All stages of testing are evaluated using visual examination criteria. Workmanship qualifications are *summative tests* and may be conducted at any time during training, once the trainee has completed skills training for the welding and cutting processes specified. (Refer to Figures 2 through 6.)

Closed Book Examination: A practical knowledge test for welding related knowledge. This examination will measure the trainee's knowledge, comprehension and application of major subject matter concepts from classroom instruction. This *summative test* is administered at the end of the training cycle, before standard performance qualification.

Performance Qualification: A practical application test of manipulative skills using all arc welding processes required by AWS QC11, *Specification for the Qualification and Certification for Level II – Advanced Welders.* Performance is measured using visual examination and bend test criteria. This *summative test* is conducted at the end of the training cycle. The trainee shall pass the closed book examination before taking this set of tests. (Refer to Figure 7). Participating Organizations may elect to use, or become, AWS Accredited Test Facilities under the requirements of AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program* and administer performance qualifications, then certify advanced welders according to the requirements of AWS QC7, *Standard for AWS Certified Welders* and section 4. *Optional Welder Qualification – AWS QC7 – Certified Welders* of this guide.

3.1.3 Curriculum Implementation.

3.1.3.1 Review. Participating Organizations shall review part **3.2 Competency-Based Program Outline** (all inclusive) and **3.3 Learning Modules** (all inclusive), prior to the introduction of the curriculum into the training cycle.

Note: The Competency-Based Program Outline should not be construed as the steps necessary to administer the curriculum. It, as the title implies, is an outline that may be used to quickly identify a point in training. The Learning Modules are the heart of the curriculum and contain sufficient information for instructors to deliver the training and evaluate a trainee's performance. Learning Modules include course title, learning objectives, performance conditions, desired behavior, evaluation criteria and learning activities.

3.1.3.2 Verification. Participating Organizations shall ensure that their existing or newly developed curriculum is in compliance with all AWS documents specified in part **3.3 Learning Modules**. Verification shall be made in writing in accordance with AWS QC11, *Specification for the Qualification and Certification for Level II – Advanced Welders.*

3.1.3.3 Lesson Plan Development. Participating Organizations shall develop appropriate lesson plans that include each learning objective and the learning activities specified for each course or unit within a course. (Refer to 3.3 Learning Modules.)

Note: Not all learning objectives are stand alone in terms of instruction. Some are delivered through a minimum period of instruction and reinforced throughout the training cycle. Determination of stand alone or continuous reinforcement is identified in the evaluation criteria for each learning objective.

3.1.3.4 Delivery. It is the sole responsibility of a Participating Organization to determine sequencing of instruction. However, Participating Organizations shall deliver training in accordance with the learning objectives and learning activities detailed in **3.3 Learning Modules**.

3.1.3.5 Testing. Participating Organizations shall develop and administer appropriate formative tests during and after the completion of classroom instruction. Summative testing for workmanship qualification, (see Figures 2 through 6), should be administered at the end of training in each applicable welding or cutting process. Workmanship qualifications must be administered prior to summative testing for practical knowledge and performance qualification. Summative testing for practical knowledge, and performance qualification (see Figure 7), shall be administered at the end of the training cycle in accordance with the requirements of AWS QC11, *Specification for the Qualification and Certification for Level II – Advanced Welders.*

Participating organizations electing to use the QC7 option of AWS QC11 may substitute any workmanship or performance qualification test detailed in **3.3 Learning Modules** for the applicable welder performance qualification test detailed in section **4. Optional Welder Qualification – AWS QC7 – Certified Welders**. When an optional QC7 performance qualification test is substituted, it shall not be necessary to duplicate the applicable workmanship or performance qualification test from **3.3 Learning Modules** of this guide.

3.1.3.6 Record Keeping. Participating Organizations shall develop appropriate records that track each trainee's achievements. In addition, appropriate records shall be developed so that trainees may keep a self-record of achievement. See Annex E.

3.2 Competency Based Program Outline

3.2.1 Program: Level II – ADVANCED WELDER TRAINING

3.2.1.1 COURSE A: OCCUPATIONAL ORIENTATION

Unit : (no units this course)
Learning Objectives
(1) Follow safe practices.
(2) Prepare time or job cards, reports or records.
(3) Perform housekeeping duties.
(4) Follow verbal instructions to complete work assignments.
(5) Follow written details to complete work assignments.

3.2.1.2 COURSE B: LAYOUT AND FITUP

Unit 1: INTRODUCTION TO SHOP EQUIPMENT
Learning Objectives
(1) Follow safe operating procedures.
(2) Select shop equipment.
(3) Set up shop equipment.
(4) Operate shop equipment.
(5) Operate lifting equipment.

Unit 2: MEASUREMENT FOR LAYOUT
Learning Objectives
(1) Layout parts using advanced measurement practices.

Unit 3: LAYOUT TOOLS FOR GEOMETRIC CONSTRUCTION
Learning Objectives
(1) Follow safe handling procedures.
(2) Select layout tools.

Unit 4: LAYOUT PRINCIPLES and PRACTICES
Learning Objectives
(1) Interpret drawing, sketch or specification information.
(2) Prepare work area for layout.
(3) Prepare material lists.
(4) Select material.
(5) Layout material.

Unit 5: PART PREPARATIONS – CUTTING and FORMING

Learning Objectives

(1) Perform bending or forming operations.
(2) Perform drilling or boring operations.
(3) Perform shearing operations.
(4) Perform oxyfuel gas cutting, beveling and piercing operations.
(5) Perform arc cutting, beveling and piercing operations.

Unit 6: FITUP PRINCIPLES and PRACTICES

Learning Objectives

(1) Fitup parts or assembles.

3.2.1.3 COURSE C: DOCUMENTS GOVERNING WELDING AND WELDING INSPECTION

Unit1: WELDING CODES and OTHER STANDARDS

Learning Objectives

(1) Locate essential welding information from a code or other standard.

Unit 2: QUALIFICATION AND CERTIFICATION

Learning Objectives

(1) Locate essential information for welding procedure and performance qualification.

3.2.1.4 COURSE D: INTRODUCTION TO WELDING METALLURGY

Unit:(no units this course)

Learning Objectives

(1) Recognize fundamental principles related to welding metallurgy.
(2) Recognize fundamental principles related to the properties of metals.
(3) Recognize fundamental principles related to residual stress and distortion.

3.2.1.5 COURSE E: WELDING INSPECTION and TESTING PRINCIPLES

Unit 1: WELDING INSPECTION AND TESTING

Learning Objectives

(1) Recognize the role of welding inspection and testing in industry.

Unit 2: VISUAL EXAMINATION PRINCIPLES AND PRACTICES

Learning Objectives

(1) Examine cut surfaces and edges of prepared base metal parts.
(2) Examine tack, intermediate layers, and completed welds.

3.2.1.6 COURSE F: ARC WELDING PRINCIPLES and PRACTICES

Unit 1: SHIELDED METAL ARC WELDING (SMAW)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for shielded metal arc welding operations.
(4) Operate shielded metal arc welding equipment.
(5) Execute corrective actions to repair surface flaws on welds and base metals.
(6) Make fillet welds, all positions, on carbon steel or stainless steel plate using stainless steel electrodes.
(7) Make groove welds, all positions, on carbon steel or stainless steel plate using stainless steel electrodes.
(8) Perform an all position workmanship qualification test on carbon steel or stainless steel plate using stainless steel electrodes.
(9) Make fillet welds, all positions, on carbon steel pipe.
(10) Make 2G, 5G and 6G groove welds, on carbon steel pipe.
(11) Perform a 6G unlimited thickness qualification test on carbon steel pipe.

Unit 2: GAS METAL ARC WELDING (GMAW, GMAW–S)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for gas metal arc welding operations on carbon steel.
(4) Operate gas metal arc welding equipment.
(5) Execute corrective actions to repair surface flaws on welds and base metals.

Spray transfer

(6) Make fillet welds, all positions, on aluminum plate.
(7) Make groove welds, all positions, on aluminum plate.
(8) Perform an all position workmanship qualification test on aluminum plate.
(9) Make fillet welds in the 2F position, on carbon steel pipe, using spray transfer.

Short circuit transfer

(10) Make fillet welds, all positions, on carbon steel pipe, using short circuiting transfer.
(11) Make 2G and 5G groove welds, on carbon steel pipe, using short circuiting transfer.

Short circuit transfer & Spray transfer

(12) Perform a combination workmanship qualification test on carbon steel pipe & plate.

Unit 3: FLUX CORED ARC WELDING (FCAW–S, FCAW–G)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for flux cored arc welding operations on carbon steel.
(4) Operate flux cored arc welding equipment.
(5) Execute corrective actions to repair surface flaws on welds and base metals.

Self-Shielded

(6) Make fillet welds, all positions, on carbon steel pipe, using self-shielded electrodes.
(7) Make 2G and 5G groove welds, on carbon steel pipe, using self-shielded electrodes.

Gas-Shielded

(8) Make fillet welds, all positions, on carbon steel pipe, using gas-shielded electrodes.
(9) Make 2G and 5G groove welds, on carbon steel pipe, using gas-shielded electrodes.

Self-Shielded and Gas-Shielded

(10) Perform a combination workmanship qualification test on carbon steel pipe & plate.

Unit 4: GAS TUNGSTEN ARC WELDING (GTAW)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for gas tungsten arc welding operations on carbon steel, aluminum, and stainless steel.
(4) Operate gas tungsten arc welding equipment.
(5) Execute corrective actions to repair surface flaws on welds and base metals.
(6) Make 3F and 4F fillet welds, on aluminum sheet.
(7) Make 2G – 4G groove welds on aluminum sheet.
(8) Make 4F fillet welds, on stainless steel sheet.
(9) Make 3G – 4G groove welds on stainless steel sheet.
(10) Make fillet welds, all positions, on carbon steel round tubing.
(11) Make fillet welds, all positions, on aluminum round tubing.
(12) Make fillet welds, all positions, on stainless round tubing.
(13) Make 2G and 5G groove welds, on carbon steel round tubing.
(14) Make 2G and 5G groove welds, on aluminum round tubing.
(15) Make 2G and 5G groove welds, on stainless steel round tubing.
(16) Perform combination workmanship qualification tests on carbon steel round tubing & sheet.
(17) Perform combination workmanship qualification tests on aluminum round tubing & sheet.
(18) Perform combination workmanship qualification tests on stainless steel round tubing & sheet.

3.3 LEARNING MODULES

3.3.1 COURSE A: OCCUPATIONAL ORIENTATION

LEARNING OBJECTIVE #1: Follow Safe Practices.

PERFORMANCE CONDITIONS: Provided with a period of instruction, orientation and demonstration about general welding safety, and given the necessary personal protective clothing and equipment, in the work area.

DESIRED BEHAVIOR: the trainee demonstrates safe practices.

EVALUATION CRITERIA: With regard to the trainee, proper protective clothing and equipment are worn, a safe work area is maintained and hazard warnings are communicated to other personnel in the immediate vicinity. The trainee performs the task on a continuous basis over the length of the program, in accordance with the institution's safety policy. Prior to any performance related activity in the institution's work area, the trainee shall pass with 100% accuracy, a written safety examination related to applicable sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*, and the participating organization's internal safety policy. The trainee may retest until 100% accuracy is achieved.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide a safety tour and orientation in the institution's welding work area.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 4. Protection of Personnel and the General Area.
4. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 5. Ventilation.
5. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 6. Fire Prevention and Protection.
6. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 9. Precautionary Information.
7. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I – General Aspects.
8. Administer safety examination prior to trainee performance in the institution's work area.
9. Administer safety examination retests as applicable.
10. Keep records reflecting successful completion of safe practice training.

LEARNING OBJECTIVE #2: Prepare time or job cards, reports or records.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, a time record, and job or work assignment number.

DESIRED BEHAVIOR: the trainee records personal training and job assignment information.

EVALUATION CRITERIA: The trainee's time records are completed in accordance with the institution's standard operating procedures. The record is returned or entered into the proper filing area or storage media. The trainee performs the task on a continuous basis over the length of the program. The trainee's completed record is compared against the instructor's master record for accuracy.

LEARNING ACTIVITIES:

The instructor shall:

1. Develop a trainee achievement record.
2. Develop a trainee time record.
3. Demonstrate procedures for completion of training achievement records and time cards.
4. Provide instruction related to time and job recording methods related to the welding industry.
5. Provide training exercises related to trainee maintenance of a training achievement record.
6. Provide training exercises related to trainee maintenance of a time card.
7. Monitor individual training achievement records and time cards.
8. Keep training records reflecting trainee achievement and attendance.

LEARNING OBJECTIVE #3: Perform housekeeping activities.

PERFORMANCE CONDITIONS: Provided with a period of orientation, housekeeping equipment or tools, and given a housekeeping assignment, in the work area,

DESIRED BEHAVIOR: the trainee will carry out housekeeping activities.

EVALUATION CRITERIA: The trainee's completed assignments show evidence of good housekeeping and safety practices. The assignment is completed in accordance with the institution's standard operating procedure. The task is completed in a timely manner. The trainee's workmanship is observed by the instructor on a routine basis over the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Outline common housekeeping activities shared by all trainees.
2. Outline individual housekeeping responsibilities.
3. Provide housekeeping activities for all trainees.
4. Monitor and inspect completed individual and shared housekeeping assignments.
5. Keep training records reflecting trainee housekeeping habits.

LEARNING OBJECTIVE #4: Follow verbal instructions to complete work assignments.

PERFORMANCE CONDITIONS: Given verbal work assignment instructions and the required materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will carry out a job assignment.

EVALUATION CRITERIA: The trainee's work assignment is completed according to verbal instructions. The instructor observes the trainee selecting the necessary materials, equipment or tools to meet service conditions for the job requirements. The trainee sets up and completes assignments in a timely manner. Verbal instructions are carried out on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the welding terms and definitions element of a summative closed book examination from the related sections of ANSI/AWS A3.0, *Standard Welding Terms and Definitions*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Develop training exercises that require a trainee to follow verbal instructions and use proper terms and definitions during the course of communication.
3. Observe each trainee selecting the required materials, equipment and tools for each exercise.
4. Observe each trainee's ability to carry out training exercises.
5. Develop and administer formative or diagnostic tests relevant to welding terms and definitions.
6. Prepare trainee for the welding terms and definitions element of a summative closed book examination [summative testing].
7. Keep training records reflecting each trainee's listening and oral communication skills.

LEARNING OBJECTIVE #5: Follow written instructions to complete work assignments.

PERFORMANCE CONDITIONS: Given written work assignment instructions and the required materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will carry out a job assignment.

EVALUATION CRITERIA: The trainee's work assignment is completed according to written instructions. The trainee is observed by the instructor selecting the necessary materials, equipment or tools to meet service conditions for the job requirements. The trainee sets up and completes the assignment in a timely manner. Written instructions are carried out on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the welding terms and definitions element of a summative closed book examination from the related sections of ANSI/AWS A3.0, *Standard Welding Terms and Definitions*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction in welding terms and definitions.
3. Develop training exercises that require a trainee to follow written instructions.
4. Observe each trainee selecting the required materials, equipment and tools for each exercise.
5. Observe each trainee's ability to carry out training exercises.
6. Develop and administer formative or diagnostic tests relevant to welding terms and definitions.
7. Prepare trainee for the welding terms and definitions element of a closed book written examination [summative testing].
8. Keep training records reflecting each trainee's written communication skills.

3.3.2 COURSE B: LAYOUT AND FITUP

3.3.2.1 UNIT #1: INTRODUCTION TO SHOP EQUIPMENT*

LEARNING OBJECTIVE #1: Follow safe operating procedures.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection and safe operation guidelines, protective clothing and equipment, various shop equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections and demonstrates safe operating procedures for various shop equipment and accessories.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, shop equipment and accessories meet safety requirements. The trainee is observed performing safety inspections of shop equipment and accessories prior to the start of operation. Hazard warnings are communicated to others in the immediate area prior to the start of equipment operation. In the course of daily operations, the trainee is observed following safe operating procedures in accordance with manufacturer's recommendations and the training facility's institutional policy. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the documents specified for this learning objective.
2. Provide a safety tour and orientation for shop equipment and accessories.
3. Provide demonstrations related to safety inspections of shop equipment and accessories.
4. Provide instruction related to safety inspections of shop equipment and accessories.
5. Provide demonstrations related to safe operation of shop equipment and accessories.
6. Provide instruction related to safe operation of shop equipment and accessories.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safety inspections and safe operating procedures for shop equipment and accessories.
12. Keep records reflecting successful completion of safety inspections and safe operating procedures for shop equipment and accessories.

***NOTE:** **Shop equipment could include: iron workers, shears, rollers, press brake, drill press, etc. That is, any piece of equipment relevant to a training institution's unique laboratory situation other than welding or flame/arc cutting equipment.**

LEARNING OBJECTIVE #2: Select shop equipment*.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, various shop equipment and accessories, in the work area,

DESIRED BEHAVIOR: the trainee selects proper shop equipment and accessories for various job assignments.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, shop equipment and accessories meet safety requirements. The trainee is observed selecting the proper shop equipment and accessories prior to the start of a job assignment. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction about shop equipment and accessory functions.
3. Demonstrate shop equipment and accessory capabilities.
4. Provide training exercises related to the selection of shop equipment and accessory for various assignments.
5. Introduce related terms and definitions.
6. Observe trainee selecting shop equipment and accessories for various assignments.
7. Observe trainee using proper terms and definitions.
8. Develop and administer formative or diagnostic tests relevant to shop equipment and accessory selection.
9. Keep training records reflecting results of shop equipment and accessory selection training.

***NOTE: Shop equipment could include: iron workers, shears, rollers, press brake, drill press, etc. That is, any piece of equipment relevant to a training institution's unique laboratory situation other than welding or flame/arc cutting equipment.**

LEARNING OBJECTIVE #3: Set up shop equipment*.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, various shop equipment and accessories, and a job assignment, in the work area.

DESIRED BEHAVIOR: the trainee sets up shop equipment and accessories for various job assignments.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, shop equipment and accessories meet safety requirements. The trainee has selected the proper shop equipment and accessories. The trainee is observed setting up shop equipment and accessories prior to the start of a job assignment. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Demonstrate shop equipment and accessory setup.
2. Provide practice related to shop equipment and accessory setup.
3. Observe trainee selecting shop equipment and accessories.
4. Observe trainee performance during various stages of shop equipment and accessory setup.
5. Observe trainee following safe practices.
6. Develop and administer formative or diagnostic tests relevant to shop equipment and accessory setup.
7. Prepare trainee for the shop equipment and accessory setup elements of workmanship qualifications.
8. Keep training records reflecting results of shop equipment and accessory setup.

The training facility should:

1. Provide trainee with experiential learning related to shop equipment setup (e.g. field studies, work study or manufacturer demonstrations of various shop equipment used in welded metal fabrication).

*NOTE: **Shop equipment could include: iron workers, shears, rollers, press brake, drill press, etc. That is, any piece of equipment relevant to a training institution's unique laboratory situation other than welding or flame/arc cutting equipment.**

LEARNING OBJECTIVE #4: Operate shop equipment*.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, various shop equipment and accessories, and a job assignment, in the work area,

DESIRED BEHAVIOR: the trainee operates shop equipment and accessories for various job assignments.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, shop equipment and accessories meet safety requirements. The trainee has selected the proper shop equipment and accessories. The trainee is observed setting up shop equipment and accessories prior to the start of a job assignment. The trainee is observed operating shop equipment and accessories during a job assignment. The trainee is observed following safe operating procedures in accordance with the training facility's procedures and equipment manufacturer's recommendations. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the documents specified for this learning objective.
2. Reinforce shop equipment safe operating procedures.
3. Provide demonstrations related to shop equipment operations.
4. Provide instruction related to shop equipment principles of operation.
5. Provide trainee with shop equipment operation performance exercises.
6. Observe trainee following safe shop equipment operation performance exercises.
7. Observe trainee operating shop equipment.
8. Visually inspect trainee's completed work assignments.
9. Develop and administer formative or diagnostic tests relevant to shop equipment principles of operation.
10. Keep training records reflecting results of shop equipment principles of operation and performance exercises.

The training facility should:

1. Provide trainee with experiential learning related to shop equipment operation (e.g. field studies, work study or manufacturer hands-on type demonstrations of various shop equipment used in welded metal fabrication).

*NOTE: **Shop equipment could include: iron workers, shears, rollers, press brake, drill press, etc. That is, any piece of equipment relevant to a training institution's unique laboratory situation other than welding or flame/arc cutting equipment.**

LEARNING OBJECTIVE #5: Operate lifting equipment*.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, various lifting equipment and accessories, and a job assignment, in the work area.

DESIRED BEHAVIOR: the trainee operates lifting equipment and accessories for various job assignments.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, lifting equipment and accessories meet safety requirements. The trainee has selected the proper lifting equipment and accessories. The trainee is observed setting up, rigging, operating and using proper hand signals during various stages of lifting equipment and accessory operations. The trainee is observed following safe lifting procedures in accordance with the training facility's procedures and equipment manufacturer's recommendations. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the documents specified for this learning objective.
2. Provide instruction related to lifting equipment safe operating procedures.
3. Provide instruction related to rigging operations.
4. Provide instruction related to hand signals for lifting equipment operations.
5. Provide instruction related to lifting equipment principles of operation.
6. Provide demonstrations related to rigging operations.
7. Provide demonstrations related to hand signals for lifting equipment operations.
8. Provide demonstrations related to lifting equipment principles of operation.
9. Provide trainee with lifting equipment operation performance exercises.
10. Observe trainee following lifting equipment safe operating procedures.
11. Observe trainee setting up, rigging, signaling and operating lifting equipment during various stages of a job assignment.
12. Develop and administer formative or diagnostic tests relevant to setting up, rigging, signaling and safe operation of lifting equipment.
13. Keep training records reflecting results of setting up, rigging, signaling and safe operation of lifting equipment.

The training facility should:

1. Provide trainee with experiential learning related to lifting equipment operation (e.g. field studies, work study or manufacturer hands-on type demonstrations of various shop lifting equipment used in welded metal fabrication).

***NOTE:** **Lifting equipment and accessories could include: come alongs, hoists, fork lifts, plate dogs, slings, etc., That is, any piece of lifting equipment relevant to a training institution's unique laboratory situation, or common lifting equipment used by all welding personnel. With the exception of a fork lift, this does not include over the road or operator driven lifting equipment such as a crane.**

3.3.2.2 UNIT #2: MEASUREMENT FOR LAYOUT

LEARNING OBJECTIVE #1: Layout parts using advanced measurement practices.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, mathematical charts, formulas, an appropriate calculator, and a work assignment.

DESIRED BEHAVIOR: the trainee performs calculations related to part preparation and component assembly during various stages of layout and fitup.

EVALUATION CRITERIA: The trainee's completed product meets the design specifications for a particular job assignment. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to the use of mathematical formulas to determine allowances for bending operations.
2. Provide demonstrations related to the use of setback charts for sheet or plate bending operations.
3. Provide demonstrations related to the use of geometric principles to determine angles, intersecting lines, cutouts, positions and lengths, during layout or fitup operations.
4. Provide demonstrations related to the use of trigonometric functions to determine angles, intersecting lines, cutouts, positions and lengths, during layout or fitup operations.
5. Provide demonstrations related to the use of trigonometry tables or calculator functions to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
6. Provide training exercises related to the use of mathematical formulas to determine allowances for bending operations.
7. Provide training exercises related to the use of setback charts for sheet or plate bending operations.
8. Provide training exercises related to the use of geometric principles to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
9. Provide training exercises related to the use of trigonometric functions to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
10. Provide training exercises related to the use of trigonometry tables or calculator functions to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
11. Develop and administer formative or diagnostic tests relevant to advanced measurement practices.
12. Keep records reflecting successful completion of advanced measurement practices training.

The training facility should:

1. Provide demonstrations related to the use of mathematical formulas to determine allowances for bending operations.
2. Provide demonstrations related to the use of setback charts for sheet or plate bending operations.
3. Provide demonstrations related to the use of geometric principles to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
4. Provide demonstrations related to the use of trigonometric functions to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
5. Provide demonstrations related to the use of trigonometry tables or calculator functions to determine angles, intersecting lines, cutouts, positions and lengths during layout or fitup operations.
6. Develop and administer formative or diagnostic tests relevant to advanced measurement instruction.
7. Keep records reflecting successful completion of advanced measurement training.

3.3.2.3 UNIT #3: LAYOUT TOOLS FOR GEOMETRIC CONSTRUCTION*

LEARNING OBJECTIVE #1: Follow safe handling procedures.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safe layout tool handling and maintenance guidelines, protective clothing and equipment, various layout tools, and a job assignment, in the work area.

DESIRED BEHAVIOR: the trainee demonstrates safe handling and care of various layout tools during the course of a job assignment.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, and layout tools meet safety requirements. The trainee is observed safely handling layout tools during various stages of layout and fitup. The trainee is observed maintaining layout tools in accordance with manufacturer's recommendations and the training facility's institutional policy. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the documents specified for this learning objective.
2. Provide a safety orientation for shop layout tools.
3. Provide instruction related to safe handling of shop layout tools.
4. Provide instruction related to the maintenance of shop layout tools.
3. Provide demonstrations related to safe handling of shop layout tools.
4. Provide demonstrations related to the maintenance of shop layout tools.
7. Introduce related terms and definitions.
3. Provide training exercises related to safe handling of shop layout tools.
4. Provide training exercises related to the maintenance of shop layout tools.
8. Observe trainee following safe handling and maintenance procedures for shop layout tools.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe handling and maintenance of shop layout tools.
12. Keep records reflecting successful completion of safe handling and maintenance of shop layout tools training.

***NOTE:** **Shop layout tools could include: framing squares, tri-squares, bevel gauges, bevel protractors, pipe centering tools, wing dividers, punches, scribes, trammel points, tape measures, rules, etc. That is, any measuring tool relevant to layout and fitup situations.**

LEARNING OBJECTIVE #2: Select layout tools.*

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, various shop layout tools, and a job assignment, in the work area.

DESIRED BEHAVIOR: the trainee selects the proper layout tool for various job assignments.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, and shop layout tools meet safety requirements. The trainee is observed selecting the proper shop layout tools prior to the start of a job assignment. The objective is performed as required during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction about the functions of shop layout tools.
3. Demonstrate the capabilities of shop layout tools.
4. Provide training exercises related to the selection of shop layout tools for various assignments.
5. Introduce related terms and definitions.
6. Observe trainee selecting layout tools for various assignments.
7. Observe trainee using proper terms and definitions.
8. Develop and administer formative or diagnostic tests relevant to shop layout tool selection.
9. Keep training records reflecting the results of shop layout tool selection training.

*NOTE: **Shop layout tools could include: framing squares, tri-squares, bevel gauges, bevel protractors, pipe centering and layout tools, wing dividers, punches, scribes, trammel points, tape measures, rules, etc. That is, any measuring tool relevant to layout and fitup situations.**

3.3.2.4 UNIT #4: LAYOUT PRINCIPLES AND PRACTICES

LEARNING OBJECTIVE #1: Interpret drawing, sketch or specification information.

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration and practice, a drawing, sketch or specification package, pen or pencil, notepad, hand held calculator, and a job assignment, at a work area table,

DESIRED BEHAVIOR: the trainee is able to identify the individual components of a welded assembly.

EVALUATION CRITERIA: Fabrication requirements are identified according to drawing, sketch, or specifications by the trainee. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee preparing to layout according to fabrication requirements. Workmanship sample information is correctly interpreted by the trainee during workmanship and performance qualification testing, and verified by the test supervisor. In accordance with the requirements of AWS QC11, and AWS Welding Handbook, Vol. 1, Eighth Ed., Chapter 5, *Design for Welding*, the trainee shall pass the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction related to drawing, sketch and specification interpretation.
3. Provide instruction related to design for welding from the applicable sections of AWS Welding Handbook, Vol. 1, Eighth Ed., Chapter 5, *Design for Welding*. (See note)
4. Provide instruction related to the interpretation of drawings, sketches or specifications for sheet metal, structural and pipe components.
5. Provide demonstrations related to drawing, sketch and specification interpretation.
6. Provide demonstrations related to design for welding.
7. Provide demonstrations related to the interpretation of drawings, sketches or specifications for sheet metal, structural and pipe components.
8. Introduce related terms and definitions.
9. Provide training exercises related to drawing, sketch, specification interpretation and design for welding.
10. Develop and administer formative or diagnostic tests relevant to drawing, sketch, specification interpretation and design for welding.
11. Prepare trainee for the layout and fitup elements of a closed book written examination and workmanship and performance qualification testing [summative testing].
12. Keep training records reflecting results of drawing, sketch, specification interpretation and design for welding requirements.

NOTE: **The "Properties of Metals" section from AWS Welding Handbook, Vol. 1, Eighth Ed., Chapter 5, *Design for Welding*, does not need to be presented. "Properties of Metals" will be presented in Course D – Introduction to Welding Metallurgy.**

LEARNING OBJECTIVE #2: Prepare work area for layout.*

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration and practice, a drawing, sketch or specification package, pen or pencil and soapstone, notepad, hand held calculator, appropriate measuring devices and a job assignment, at a work area table,

DESIRED BEHAVIOR: the trainee is able to layout a work area table for fitup.

EVALUATION CRITERIA: Fabrication requirements are identified according to drawing, sketch, or specifications by the trainee. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee preparing the layout table according to fabrication requirements. Workmanship sample information is correctly interpreted during workmanship and performance qualification testing and verified by the test supervisor. In accordance with the requirements of AWS QC11, and AWS Welding Handbook, Volume 1, Eighth Ed., *Fixtures and Positioners,* the trainee shall pass the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction related to work area preparation during layout.
3. Provide instruction related to fixtures for welded metal fabrication.
4. Provide instruction related to positioners for welded metal fabrication.
5. Provide demonstrations related to work area preparation during layout.
6. Provide demonstrations related to fixtures for welded metal fabrication.
7. Provide demonstrations related to positioners for welded metal fabrication.
8. Provide training exercises related to work area preparation during layout.
9. Provide training exercises related to fixtures for welded metal fabrication.
10. Provide training exercises related to positioners for welded metal fabrication.
11. Introduce related terms and definitions.
12. Develop and administer formative or diagnostic tests relevant to work area preparation for layout and the use of fixtures and positioners.
13. Prepare trainee for the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].
14. Keep training records reflecting results of work area preparation for layout.

The training facility should:

1. Provide trainee with experiential learning related to layout (e.g. field studies, work study or manufacturer demonstrations of various fixtures and positioners used in welded metal fabrication).

***NOTE:** **The trainee is not expected to construct complex fixtures or positioning equipment. However, some type of project should be included in laboratory exercises that is relevant to the use of a positioner and the construction of a simple fixture used during layout and fitup of production runs. (e.g. have the trainee layout a small hand rail section [using soapstone lines not material] on a work area table and build a simple fixture to hold it. Laying out a project on the table also assists in accurately estimating the linear footage of product forms or size of plate required for a job. This method also aids in the reduction of wasted material and provides the instructor with a means to check the accuracy of the trainee's layout.**

LEARNING OBJECTIVE #3: Prepare material lists.*

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration and practice, a drawing, sketch or specification package, pen or pencil, notepad, hand held calculator, various base metals, and a job assignment, at a work area table.

DESIRED BEHAVIOR: the trainee makes a list of materials required for a given job assignment.

EVALUATION CRITERIA: Material requirements are identified according to drawing, sketch,or specification information. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee preparing a material list according to job assignment requirements. The trainee's material list correctly identifies material size specifications for a variety of product forms. In accordance with the requirements of AWS QC11, the trainee shall pass the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to the identification of, and size specifications for common product forms.
2. Provide instruction related to the use of resource material* to identify various elements* of common product forms.
3. Provide instruction related to the development of a material list from a drawing, sketch or specification package.
4. Provide demonstrations related to the identification of, and size specification recording for common product forms.
5. Provide demonstration related to the use of resource material* to identify various elements* of common product forms.
6. Provide demonstration related to the development of a material list from a drawing, sketch or specification package.
7. Provide training exercises related to the identification of, and size specification recording for common product forms.
8. Provide training exercises related to the use of resource material* to identify various elements* of common product forms.
9. Provide training exercises related to the development of a material list from a drawing, sketch or specification package.
10. Prepare trainee for the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].
11. Keep training records reflecting results of material list preparation.

The training facility should:

1. Provide trainee with experiential learning related to material identification (e.g. field studies, work study or manufacturer demonstrations of various product forms used in welded metal fabrication).

*NOTE: **Resource material could include; local supplier catalogues, ASTM standards, inventory lists, etc. Elements of common product forms could include; flange size, web size, etc. Resource material can be used to determine part size in lieu of stock not in inventory. For the case of this learning activity, "material list" is not the same as a "bill of materials". A "bill of materials" is used to order materials not in inventory and is generally a broad estimate of required material.**

LEARNING OBJECTIVE #4: Select material.

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration and practice, a material list, suitable measuring tool and various base metals for a job assignment.

DESIRED BEHAVIOR: the trainee selects the required material for a given job assignment.

EVALUATION CRITERIA: Material requirements are identified according to material list specification. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee selecting material according to job assignment requirements. The trainee correctly identifies material size specifications for a variety of product forms. In accordance with the requirements of AWS QC11, the trainee shall pass the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to material storage and retrieval systems.
2. Provide instruction related to the selection of "short stock" versus "full stock" material.
3. Provide instruction related to the use of resource material to select common product forms.
4. Provide instruction related to the selection of common product forms.
5. Provide instruction related to selecting multiple parts from a single product form.
6. Provide demonstration related to material storage and retrieval systems.
7. Provide demonstration related to the selection of "short stock" versus "full stock" material.
8. Provide demonstration related to the use of resource material to select common product forms.
9. Provide demonstration related to the selection of common product forms.
10. Provide demonstration related to selecting multiple parts from a single product form.
11. Provide training exercises related to material storage and retrieval systems.
12. Provide training exercises related to the selection of "short stock" versus "full stock" material.
13. Provide training exercises related to the use of resource material to select common product forms.
14. Provide training exercises related to the selection of common product forms.
15. Provide training exercises related to selecting multiple parts from a single product form.
16. Develop and administer formative or diagnostic tests relevant to material selection.
17. Prepare trainee for the layout and fitup portions of closed book, workmanship and performance qualification examinations [summative testing].
18. Keep training records reflecting results of material selection training.

The training facility should:

1. Provide trainee with experiential learning related to material selection (e.g. field studies, work study or manufacturer demonstrations of various product forms used in welded metal fabrication).

LEARNING OBJECTIVE #5: Lay out material.

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration and practice, a drawing, sketch or specification package, suitable layout tools and various base metals for a job assignment, at a work area table.

DESIRED BEHAVIOR: the trainee lays out parts from the required material for a given job assignment.

EVALUATION CRITERIA: All components of a drawing, sketch or specification package have been properly identified, marked and layed out for further processing. The trainee selects the correct layout method. The trainee has selected the proper layout tools for the given assignment. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee laying out material according to job assignment requirements. In accordance with the requirements of AWS QC11, the trainee shall pass the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Reinforce a safety instruction and demonstration from previous learning activities related to layout and fitup.
2. Reinforce previous instruction and demonstration for the care and use of shop layout tools.
3. Provide instruction related to the sequencing of layout operations from a drawing, sketch or specification package.
4. Provide instruction in various methods related to part layout for sheet metal, structural and pipe fabrications.
5. Provide instruction in various methods used to identify ("piece mark") individual components of a fabricated weldment.
6. Provide demonstration related to the sequencing of layout operations from a drawing, sketch or specification package.
7. Provide demonstration in various methods related to part layout for sheet metal, structural and pipe fabrications.
8. Provide demonstration in various methods used to identify ("piece mark") individual components of a fabricated weldment.
9. Provide training exercises related to part layout for various sheet metal, structural and pipe fabrications. (e.g. make templates for laying out saddles on various diameters of pipe)
10. Introduce related terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to material layout.
12. Prepare trainee for the layout and fitup elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].
13. Keep training records reflecting results of material layout.

The training facility should:

1. Provide trainee with experiential learning related to material layout (e.g. field studies, work study or manufacturer demonstrations of common techniques used to prepare the surfaces and edges of various product forms used in welded metal fabrication).

3.3.2.5 UNIT #5: PART PREPARATIONS – CUTTING AND FORMING

LEARNING OBJECTIVE #1: Perform bending or forming operations.

PERFORMANCE CONDITIONS: Provided with a period of demonstration and practice, verbal or written instructions, appropriate shop equipment and measuring tools, protective clothing and equipment, and prepared (layed out) pieces of material for a bending or forming assignment, in the work area,

DESIRED BEHAVIOR: the trainee performs bending or forming operations for a given job assignment.

EVALUATION CRITERIA: Fabrication requirements are identified by the trainee according to verbal or written instructions. The trainee has correctly identified the pieces targeted for bending or forming. The trainee's bent or formed parts meet design specification. The objective is practiced on a routine basis over the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Reinforce safe operating procedures from previous learning activities for layout and fitup.
2. Reinforce previous instruction and demonstration from introduction to shop equipment.
3. Reinforce previous instruction and demonstration from measurement for layout.
4. Demonstrate bending or forming techniques for sheet metal, structural and pipe fabrication.
5. Provide training exercises related to bending or forming operations for sheet metal, structural and pipe fabrication.
6. Develop and administer formative or diagnostic tests relevant to bending or forming operations.
7. Keep training records reflecting results of bending or forming operations training.

The training facility should:

1. Provide trainee with experiential learning related to bending or forming operations (e.g. field studies, work study or manufacturer demonstrations of common bending or forming operations used in welded metal fabrication).

LEARNING OBJECTIVE #2: Perform drilling or boring operations.

PERFORMANCE CONDITIONS: Provided with a period of demonstration and practice, verbal or written instructions, appropriate shop equipment and measuring tools, protective clothing and equipment, and prepared (layed out) pieces of material for a drilling or boring assignment, in the work area.

DESIRED BEHAVIOR: the trainee performs drilling or boring operations for a given job assignment.

EVALUATION CRITERIA: Fabrication requirements are identified by the trainee according to verbal or written instructions. The trainee has correctly identified the pieces targeted for drilling or boring. The trainee's drilled or bored parts meet design specification. The objective is practiced on a routine basis over the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Reinforce safe operating procedures from previous learning activities for layout and fitup.
2. Reinforce previous instruction and demonstration from introduction to shop equipment.
3. Reinforce previous instruction and demonstration from measurement for layout.
4. Demonstrate drilling or boring techniques for sheet metal, structural and pipe fabrication.
5. Provide training exercises related to drilling or boring operations for sheet metal, structural and pipe fabrication.
6. Develop and administer formative or diagnostic tests relevant to drilling or boring operations.
7. Keep training records reflecting results of drilling or boring operations training.

The training facility should:

1. Provide trainee with experiential learning related to drilling or boring operations (e.g. field studies, work study or manufacturer demonstrations of common drilling or boring operations used in welded metal fabrication).

LEARNING OBJECTIVE #3: Perform shearing operations.

PERFORMANCE CONDITIONS: Provided with a period of demonstration and practice, verbal or written instructions, appropriate shop equipment and measuring tools, protective clothing and equipment, and prepared (layed out) pieces of material for a shearing assignment; in the work area,

DESIRED BEHAVIOR: the trainee performs shearing operations for a given job assignment.

EVALUATION CRITERIA: Fabrication requirements are identified by the trainee according to verbal or written instructions. The trainee has correctly identified the pieces targeted for shearing. The trainee's sheared parts meet design specification. The objective is practiced on a routine basis over the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Reinforce safe operating procedures from previous learning activities for layout and fitup.
2. Reinforce previous instruction and demonstration from introduction to shop equipment.
3. Reinforce previous instruction and demonstration from measurement for layout.
4. Demonstrate shearing techniques for sheet metal, structural and pipe fabrication.
5. Provide training exercises related to shearing operations for sheet metal, structural and pipe fabrication.
6. Develop and administer formative or diagnostic tests relevant to shearing operations.
7. Keep training records reflecting results of shearing operations training.

The training facility should:

1. Provide trainee with experiential learning related to shearing operations (e.g. field studies, work study or manufacturer demonstrations of common shearing operations used in welded metal fabrication).

LEARNING OBJECTIVE #4: Perform oxyfuel gas cutting, beveling and piercing operations.

PERFORMANCE CONDITIONS: Provided with a period of demonstration and practice, verbal or written instructions, appropriate oxyfuel gas cutting equipment, measuring tools, protective clothing and equipment, and prepared (layed out) pieces of material for an oxyfuel gas cutting assignment, in the work area,

DESIRED BEHAVIOR: the trainee performs oxyfuel gas cutting, beveling and piercing operations for a given job assignment.

EVALUATION CRITERIA: Fabrication requirements are identified by the trainee according to verbal or written instructions. The trainee has correctly identified the pieces targeted for oxyfuel gas cutting, beveling or piercing. The trainee's oxyfuel gas cut parts meet design specification. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the oxyfuel gas cutting safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.* In addition, the trainee shall pass the oxyfuel gas cutting elements of workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Reinforce safe operating procedures and orientation for oxyfuel gas cutting supply systems, equipment and accessories from previous training.
3. Reinforce previous instruction and demonstration from measurement for layout.
4. Provide instruction related to manual and machine oxyfuel gas cutting equipment set up for carbon steel pipe and tube.
5. Provide instruction related to manual and machine oxyfuel gas cutting, beveling and piercing operations on carbon steel pipe and tube.
6. Provide demonstrations related to manual and machine oxyfuel gas cutting, beveling and piercing operations on carbon steel pipe and tube.
7. Provide training exercises related to manual and machine oxyfuel gas cutting, beveling and piercing operations on carbon steel pipe and tube.
8. Provide training exercises related to manual and machine oxyfuel gas cutting, beveling and piercing operations for sheet metal, structural and pipe applications.
9. Develop and administer formative or diagnostic tests relevant to oxyfuel gas cutting, beveling and piercing operations training.
10. Prepare trainee for the oxyfuel cutting elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].
11. Keep training records reflecting results of oxyfuel gas cutting, beveling and piercing operations training.

The training facility should:

1. Provide trainee with experiential learning related to oxyfuel gas cutting, beveling and piercing operations (e.g. field studies, work study or manufacturer demonstrations of manual and machine oxyfuel gas cutting equipment used in welded metal fabrication).

LEARNING OBJECTIVE #5: Perform arc cutting, beveling and piercing operations.

PERFORMANCE CONDITIONS: Provided with a period of demonstration and practice, verbal or written instructions, appropriate arc cutting equipment, measuring tools, protective clothing and equipment, and prepared (layed out) pieces of material for an arc cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee performs arc cutting, beveling and piercing operations for a given job assignment.

EVALUATION CRITERIA: Fabrication requirements are identified by the trainee according to verbal or written instructions. The trainee has correctly identified the pieces targeted for arc cutting, beveling or piercing. The trainee's arc cut parts meet design specification. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the arc cutting safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.* In addition, the trainee shall pass the arc cutting elements of workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Reinforce safe operating procedures and orientation for arc cutting supply systems, equipment and accessories from previous training.
3. Reinforce previous instruction and demonstration from measurement for layout.
4. Provide instruction related to manual and machine plasma arc cutting equipment set up for carbon steel, aluminum and stainless steel pipe and tube.
5. Provide instruction related to manual and machine plasma arc cutting, beveling and piercing operations on carbon steel, aluminum and stainless steel pipe and tube.
6. Provide demonstrations related to manual and machine plasma arc cutting, beveling and piercing operations on carbon steel, aluminum and stainless steel pipe and tube.
7. Provide training exercises related to manual and machine plasma arc cutting, beveling and piercing operations on carbon steel, aluminum and stainless steel pipe and tube.
8. Provide training exercises related to manual and machine plasma arc cutting, beveling and piercing operations for sheet metal, structural and pipe applications.
9. Develop and administer formative or diagnostic tests relevant to plasma arc cutting, beveling and piercing operations training.
10. Prepare trainee for the arc cutting elements of a closed book written examination, and workmanship and performance qualification testing [summative testing].
11. Keep training records reflecting results of arc cutting, beveling and piercing operations training.

The training facility should:

1. Provide trainee with experiential learning related to arc cutting, beveling and piercing operations (e.g. field studies, work study or manufacturer demonstrations of manual and machine arc cutting equipment used in welded metal fabrication).

3.3.2.6 UNIT #6: FITUP PRINCIPLES AND PRACTICES

LEARNING OBJECTIVE #1: Fitup parts or assemblies.

PERFORMANCE CONDITIONS: Provided with a drawing, sketch or specification package, fitup tools, measuring devices, welding equipment, previously prepared parts and a job assignment, in the work area,

DESIRED BEHAVIOR: the trainee fits together parts of an assembly or weldment.

EVALUATION CRITERIA: The trainee fits parts according to drawing, sketch or specification package information. The trainee's completed assignment meets the design specifications of the fabrication documents. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the fitup element of workmanship and performance qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Reinforce safe practices for fabrication tools and equipment operation.
2. Provide instruction related to inspection during various stages of fitup.
3. Demonstrate fitup techniques for sheet metal, structural and pipe applications.
4. Provide training exercises related to sheet metal, structural and pipe fitup.
6. Observe trainee selecting fitup tools and equipment.
7. Observe trainee selecting fitup methods.
8. Observe trainee performance during various stages of fitup.
9. Observe trainee following safe practices.
10. Develop and administer formative or diagnostic tests relevant to fitup.
11. Prepare trainee for the fitup element of workmanship and performance qualifications.
12. Keep training records reflecting the results of fitup training.

The training facility should:

1. Provide trainee with experiential learning related to fitup operations (e.g. field studies, work study or manufacturer demonstrations of fitup tools equipment, and techniques used in welded metal fabrication).

3.3.3 COURSE C: DOCUMENTS GOVERNING WELDING AND WELDING INSPECTION

3.3.3.1 UNIT #1: WELDING CODES AND OTHER STANDARDS*

LEARNING OBJECTIVE #1: Locate essential welding information from a code or other standard.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, an applicable welding code or other standard, in the training classroom,

DESIRED BEHAVIOR: the trainee locates essential welding procedure and performance qualification information.

EVALUATION CRITERIA: The trainee demonstrates an understanding of essential welding procedure and performance qualification variables found within a code or other standard. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee relating essential welding information to classroom assignments. The trainee correctly identifies welding and visual examination criteria related to workmanship and performance qualification requirements. In accordance with the requirements of AWS QC11, the trainee shall pass an open book examination on welding specifications [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction related to definitions, sources and applications from the related section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 13, *Codes and Other Standards*.
3. Provide instruction related to welding procedure and performance qualification information from AWS B2.1, *Standard for Welding Procedure and Performance Qualification.*
4. Introduce related terms and definitions.
5. Provide demonstrations related to locating welding procedure and performance qualification information from AWS B2.1, *Standard for Welding Procedure and Performance Qualification.*
6. Provide training exercises related to locating welding procedure and performance qualification information from AWS B2.1, *Standard for Welding Procedure and Performance Qualification.*
7. Develop and administer formative or diagnostic tests relevant to welding codes and other standards.
8. Prepare trainee for the welding specifications element of a closed book written examination, and workmanship and performance qualification testing [summative testing].
9. Keep training records reflecting results of welding codes and other standards training.

***Note:** **It is not expected that the trainee memorize the information found in a code or standard. This unit of instruction is designed to provide the trainee with an understanding of information that could be used to determine welding and inspection requirements for a particular job assignment. The open book examination for this unit will consist of a mock book of specifications constructed from portions of AWS B2.1. The trainee will be required to locate answers to questions from the book of specifications. The book of specifications will consist of information that would be relevant to a welder on the job.**

3.3.3.2 UNIT #2: QUALIFICATION AND CERTIFICATION*

LEARNING OBJECTIVE #1: Locate essential information for welding procedure and performance qualification.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, welding procedure specifications and a workmanship or performance qualification testing assignment, in the training environment,

DESIRED BEHAVIOR: the trainee performs welder performance qualification tests according to referencing documents and welding procedure specification information.

EVALUATION CRITERIA: The trainee demonstrates an understanding of welding procedure and performance qualification variables found within welding procedures specifications and other referencing documents. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the qualification and certification element of a closed book written examination from the applicable section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 14, *Qualification and Certification*. In addition, the trainee shall pass workmanship and performance qualification testing requirements according to welding procedure specifications and referencing document information.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction about the function of procedure specifications from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 14, *Qualification and Certification*.
3. Provide instruction about qualification of welding procedure specifications from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 14, *Qualification and Certification*.
4. Provide instruction about the function of performance qualification from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 14, *Qualification and Certification*.
5. Provide demonstrations related to the use of welding procedure specifications and welder performance qualification information.
6. Introduce related terms and definitions.
7. Provide training exercises related to the use of welding procedure specifications and welder performance qualification information.
8. Develop and administer formative or diagnostic tests relevant to qualification and certification training.
9. Prepare trainee for the qualification and certification element of a closed book written examination, and workmanship and performance qualification testing [summative testing].
10. Keep training records reflecting results of qualification and certification training.

*Note: **The trainee is not expected to develop a Welding Procedure Specification (WPS) or a Performance Qualification Record (PQR). This unit of instruction is designed to provide the trainee with a fundamental understanding of the qualification and certification process. The trainee shall be able to locate essential welding variables found in referencing documents and welding procedure specifications for workmanship and performance qualification testing.**

3.3.4 COURSE D: INTRODUCTION TO WELDING METALLURGY

3.3.4.1 UNIT #1: (no units this course)

LEARNING OBJECTIVE #1: Recognize fundamental principles related to welding metallurgy.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and appropriate welding metallurgy training material, in the classroom,

DESIRED BEHAVIOR: the trainee gains a fundamental understanding of welding metallurgy.

EVALUATION CRITERIA: The trainee relates basic concepts of welding metallurgy to welding situations, exhibits an understanding of the weldability of carbon steel, stainless steel and aluminum alloys, and the importance of the heat-affected zone. In accordance with the requirements of AWS QC11, the trainee shall pass the welding metallurgy element of a closed book written examination from the applicable section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 4, *Welding Metallurgy*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction about welding metallurgy from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 4, *Welding Metallurgy*.
3. Provide demonstrations related to the effects of welding in the heat-affected zone.
4. Introduce related terms and definitions.
5. Develop and administer formative or diagnostic tests relevant to welding metallurgy training.
6. Prepare trainee for the welding metallurgy element of closed book examination [summative testing].
7. Keep training records reflecting results of welding metallurgy training.

LEARNING OBJECTIVE #2: Recognize fundamental principles related to the properties of metals.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and appropriate properties of metals training material, in the classroom.

DESIRED BEHAVIOR: the trainee gains a fundamental understanding of the properties of metals.

EVALUATION CRITERIA: The trainee relates the effects of welding on the properties of metals to welding situations. In accordance with the requirements of AWS QC11, the trainee shall pass the properties of metals element of a closed book written examination from the applicable section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 5, *Design For Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction about metal properties from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 5, *Design For Welding*, Properties of Metals.
3. Provide demonstrations related to the effects of welding on the properties of metals.
4. Introduce related terms and definitions.
5. Develop and administer formative or diagnostic tests relevant to the properties of metals training.
6. Prepare trainee for the properties of metals element of closed book examination [summative testing].
7. Keep training records reflecting results of properties of metals training.

LEARNING OBJECTIVE #3: Recognize fundamental principles related to residual stress and distortion.*

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and appropriate residual stress and distortion training material, in the classroom,

DESIRED BEHAVIOR: the trainee gains a fundamental understanding of residual stress and distortion.

EVALUATION CRITERIA: The trainee relates the effects residual stress and distortion to welding situations. In accordance with the requirements of AWS QC11, the trainee shall pass the residual stress and distortion element of a closed book written examination from the applicable section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 7, *Residual Stresses and Distortion*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction about residual stress and distortion from the related section of AWS Welding Handbook, Volume 1, Eighth Ed, Chapter 7, *Residual Stresses and Distortion*.
3. Provide demonstrations related to the effects of residual stress and distortion in welding.
4. Provide demonstrations related to the reduction of residual stresses in welding.
5. Provide demonstrations related to the control of distortion in welding.
6. Provide demonstrations related to the correction of distortion in welding.
7. Introduce related terms and definitions.
8. Provide training exercises related to the control of distortion in welding.
9. Provide training exercises related to the correction of distortion in welding.
10. Develop and administer formative or diagnostic tests relevant to residual stress and distortion training.
11. Prepare trainee for the residual stress and distortion element of closed book examination [summative testing].
12. Keep training records reflecting results of residual stress and distortion training.

***Note: The trainee is not expected to understand or interpret all of the diagrams for "Measurement of Residual Stresses in Weldments". This unit of instruction is designed to provide the trainee with a fundamental understanding about residual stresses and distortion The trainee should be able to recognize techniques that the welder can use to reduce residual stresses and control or correct distortion.**

3.3.5 COURSE E: WELDING INSPECTION and TESTING PRINCIPLES

3.3.5.1 UNIT #1: WELDING INSPECTION and TESTING

LEARNING OBJECTIVE #1: Recognize the role of welding inspection and testing in industry.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, in the training facilities classroom and work area.

DESIRED BEHAVIOR: the trainee demonstrates an understanding of welding inspection and testing.

EVALUATION CRITERIA: The trainee recognizes the requirements and duties of a welding inspector, exhibits an understanding of inspection plans and the purpose of nondestructive and destructive testing during the course of daily operations. In accordance with the requirements of AWS QC11, the trainee shall pass the welding inspection and testing elements of a closed book written examination from the applicable section of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*, and AWS B4.0, *Standard Methods for Mechanical Testing of Welds*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction related to the requirements and duties of welding inspectors from the applicable sections of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*.
3. Provide instruction related to the function of inspection plans from the applicable sections of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*.
4. Provide instruction related to nondestructive examination functions and methods from the applicable sections of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*.
5. Provide instruction related to destructive testing functions and methods from the applicable sections of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*, and AWS B4.0, *Standard Methods for Mechanical Testing of Welds*.
6. Develop an inspection plan related to the visual examination of welds in the training facility's work area.
7. Demonstrate visual examination practices.
8. Develop and administer formative or diagnostic tests relevant to welding inspection and testing methods.
9. Prepare trainee for the welding inspection and testing portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 1, Eighth Ed., Chapter 15, *Inspection*, and AWS B4.0, *Standard Methods for Mechanical Testing of Welds*.
10. Keep training records reflecting results of welding inspection and testing training.

The training facility should:

1. Provide trainee with experiential learning related to welding inspection and testing (e.g. field studies, or manufacturer demonstrations of testing equipment, and inspection techniques used in welded metal fabrication).

3.3.5.2 UNIT #2: VISUAL EXAMINATION

LEARNING OBJECTIVE #1: Examine cut surfaces and edges of prepared base metal parts.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, visual examination guidelines, verbal or written instructions, protective clothing and equipment, a cutting assignment and measuring tools, in the work area,

DESIRED BEHAVIOR: the trainee performs visual examination of cut surfaces and edges.

EVALUATION CRITERIA: Verbal or written instructions are understood. Cut surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the visual examination portion of a closed book written examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting* and AWS C4.1, *Criteria for Describing Oxygen-Cut Surfaces*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to the visual examination of oxyfuel gas cut surfaces and edges.
3. Provide demonstrations related to the visual examination of arc cut surfaces and edges.
4. Provide instruction related to the visual examination of oxyfuel gas cut surfaces and edges.
5. Provide instruction related to the visual examination of arc cut surfaces and edges.
6. Provide instruction related to common cutting surface and edge discontinuities.
7. Provide training exercises related to the visual examination of oxyfuel gas cut surfaces and edges.
8. Provide training exercises related to the visual examination of arc cut surfaces and edges.
9. Observe trainee following safe visual examination practices.
10. Observe trainee performing visual examination.
11. Provide feedback to trainee about his/her visual examination diagnosis.
12. Develop and administer formative or diagnostic tests relevant to visual examination of cut surfaces and edges.
13. Prepare trainee for the visual examination portion of a closed book written examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting* and AWS C4.1, *Criteria for Describing Oxygen-Cut Surfaces*.
14. Keep training records reflecting results of visual examination of cut edges and surfaces.

LEARNING OBJECTIVE #2: Examine tack, root pass, intermediate layers and completed welds.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, visual examination guidelines, verbal or written instructions, protective clothing and equipment, a welding assignment and measuring tools, in the work area,

DESIRED BEHAVIOR: the trainee performs visual examination of tack, intermediate layers, and completed welds.

EVALUATION CRITERIA: Verbal or written instructions are understood. Welds made at various stages of the assignment are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the visual examination portion of a closed book written examination from the related sections of ANSI/AWS B1.11, *Guide for the Visual Examination of Welds.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to the visual examination of welds.
3. Provide instruction related to the visual examination of welds.
4. Provide instruction related to common weld discontinuities.
5. Provide training exercises related to the visual examination of welds.
6. Observe trainee following safe visual examination practices.
7. Observe trainee performing visual examination.
8. Provide feedback to trainee about his/her visual examination diagnosis.
9. Develop and administer formative or diagnostic tests relevant to visual examination of welds.
10. Prepare trainee for the visual examination portion of a closed book written examination from the related sections of ANSI/AWS B1.11, *Guide for the Visual Examination of Welds.*
11. Keep training records reflecting results of visual examination of welds.

3.3.6 COURSE F: ARC WELDING PRINCIPLES & PRACTICES

3.3.6.1 UNIT #1: SHIELDED METAL ARC WELDING (SMAW)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration and safety inspection guidelines, protective clothing and equipment, shielded arc welding equipment, accessories and hand tools, in the work area,

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothing, shielded metal arc welding equipment and accessories, required tools and the work area.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, welding equipment, accessories, and hand tools meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of shielded metal arc welding operations. In the course of daily operations, the trainee is observed following safe practices. The objective is performed as required during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide a safety tour and orientation for shielded metal arc welding equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine a safety inspections of protective equipment and clothing, shielded metal arc welding equipment and accessories, required tools and the work area.
5. Provide instruction related to, ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I – General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of SMAW safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to shielded metal arc welding equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs on arc welding equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment, or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the shielded metal arc welding component identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to shielded metal arc welding equipment and accessory component identification.
3. Provide instruction related to shielded metal arc welding equipment and accessory component identification
4. Provide demonstrations related to minor external repairs on shielded metal arc welding equipment and accessories.
5. Provide instruction related to minor external repairs to shielded metal arc welding equipment and accessories.
6. Introduce related terms and definitions.
7. Provide trainee with repair assignments when required.
8. Observe trainee following safe repair practices.
9. Observe trainee using proper terms and definitions.
10. Develop and administer formative or diagnostic tests relevant to shielded metal arc welding component identification.
11. Prepare trainee for the shielded metal arc welding component identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.
12. Keep training records reflecting results of shielded metal arc welding component identification.

LEARNING OBJECTIVE #3: Set up for shielded metal arc welding operations on carbon steel and stainless steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, shielded metal arc welding equipment, accessories, hand tools, base metal and E312-15/16 or E309-15/16, E3XX-15/16, E6010 or E6011, and E7018 electrodes, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform shielded metal arc welding operations on carbon steel and stainless steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, and electrodes are selected. Shielded metal arc welding equipment is set up and adjusted for the proper current and polarity. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the shielded metal arc welding principles of operation, base/filler metal selection and identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Volume 2, Eighth Ed., *Welding Processes* and ANSI/AWS A5.1, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding* and ANSI/AWS A5.4, *Specification for Corrosion-Resisting Chromium and Chromium Nickel Steel Covered Electrodes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction in AC/DC principles.
3. Provide demonstrations related to shielded metal arc welding equipment and accessory set up.
4. Provide instruction in shielded metal arc welding principles of operation.
5. Provide instruction in carbon steel and stainless steel shapes, identification and selection.
6. Provide instruction in the shielded metal arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up shielded metal arc welding equipment and accessories.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Observe trainee setting up shielded metal arc welding equipment and accessories.
12. Develop and administer formative or diagnostic tests relevant to AC/DC principles, shielded metal arc welding principles of operation and base/filler metal identification and selection.
13. Prepare trainees for the shielded metal arc welding principles of operation, carbon steel and stainless steel base/filler metal selection and identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Volume 2, Eighth Ed., *Welding Processes*, ANSI/AWS A5.1, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding* and ANSI/AWS A5.4, *Specification for Corrosion-Resisting Chromium and Chromium Nickel Steel Covered Electrodes*.
14. Keep training records reflecting results of shielded metal arc welding equipment set up, principles of operation and base/filler metal identification and selection.

LEARNING OBJECTIVE #4: Operate shielded metal arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction, and demonstration, protective clothing and equipment, shielded metal arc welding equipment accessories, E312-15/16 or E309-15/16, E3XX-15/16, E6010 or E6011, and E7018 electrodes, hand tools, base metal or an assembly and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform shielded metal arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds were visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the shielded metal arc welding principles of operation and common process variables portion of a closed book written examination from the related section of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to shielded metal arc welding equipment operations.
3. Provide instruction related to shielded metal arc welding principles of operation.
4. Provide instruction related to common process variables for shielded metal arc welding.
5. Provide training exercises related to shielded metal arc welding equipment operation.
6. Provide training exercises related to flat multi-pass surfacing welds on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel) or E3XX-15/16 electrodes.
7. Provide training exercises related to multi-pass surfacing welds in the multiple fixed position, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
9. Observe trainee following safe arc welding practices.
10. Observe trainee operating shielded metal arc welding equipment.
11. Visually inspect trainee's workmanship samples.
12. Develop and administer formative or diagnostic tests relevant to shielded metal arc welding principles of operation and common process variables.
13. Prepare trainee for the shielded metal arc welding principles of operation and common process variables portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.
14. Keep training records reflecting results of shielded metal arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5: Execute corrective action to repair surface flaws on welds and base metals.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment and accessories, shop equipment or tools, prepared base metals or an assembly, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will take corrective actions to repair surface flaws in welds or on base metals.

EVALUATION CRITERIA: The trainee's workmanship sample is free of base metal and weld metal surface flaws. The workmanship sample meets the design and welding specifications of the welding assignment. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced on an as required basis during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to the repair of surface flaws on the prepared edges and surfaces of base metals using the SMAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
2. Provide instruction related to the repair of visible surface flaws in weld metal using the SMAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
3. Provide demonstrations related to the repair of surface flaws on the prepared edges and surfaces of base metals using the SMAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
4. Provide demonstrations related to the repair of visible surface flaws in weld metal using the SMAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
5. Require the trainee to repair surface flaws on the prepared edges and surfaces of base metals.
6. Require the trainee to repair visible surface flaws in weld metal.
7. Require the trainee to notify the instructor of all repairs to surface flaws on the prepared edges and surfaces of base metals.
8. Require the trainee to notify the instructor of all repairs to visible surface flaws in weld metal.
9. Observe trainee making repairs.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to corrective actions for the repair of surface flaws in welds or base metal surfaces.
12. Keep training records reflecting the results of corrective actions for the repair of surface flaws in welds or base metal surfaces training.

LEARNING OBJECTIVE #6: Make fillet welds, all positions, on carbon steel or stainless steel plate using stainless steel electrodes.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E312-15/16, E309-15/16 or E3XX-15/16 electrodes, base metal or an assembly, hand tools, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on carbon steel or stainless steel plate in all positions using stainless steel electrodes.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding using stainless steel electrodes.
2. Provide instruction related to visual examination and repair of fillet welds produced with the shielded metal arc welding process using stainless steel electrodes.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating shielded metal arc welding equipment.
9. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
10. Visually inspect trainee's workmanship samples.
11. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
12. Keep training records reflecting results of all position stainless steel fillet welding.

LEARNING OBJECTIVE #7: Make groove welds, all positions, on carbon or stainless steel plate using stainless steel electrodes.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel), base metal or an assembly, hand tools, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make groove welds on carbon steel or stainless steel plate in all positions using stainless steel electrodes.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding using stainless steel electrodes.
2. Provide instruction related to visual examination and repair of groove welds produced with the shielded metal arc welding process using stainless steel electrodes.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
4. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
5. Provide training exercises related to 3G (vertical up), single and multiple pass groove welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
6. Provide training exercises related to 4G (overhead), single and multiple pass groove welding, on carbon steel or stainless steel plate, using E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating shielded metal arc welding equipment.
9. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
10. Visually inspect trainee's workmanship samples.
11. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
12. Keep training records reflecting results of all position stainless steel groove welding.

NOTE: When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 10.

LEARNING OBJECTIVE #8: Perform an all position workmanship qualification test, on carbon or stainless steel plate, using stainless steel electrodes.

PERFORMANCE CONDITIONS: Provided with protective clothing and equipment, shielded metal arc welding equipment, accessories, E312-15/16 or E309-15/16 (for carbon steel), or E3XX-15/16 electrodes (for stainless steel), 1/4" thick carbon steel or stainless steel plate, Welding Procedure Specification AWS2-1-SMAW or ANSI/AWS B2.1-8-023, Drawing #AWS2-1 (figure 2), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds all positions using stainless steel electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS AWS2-1-SMAW or ANSI/AWS B2.1-8-023 and Drawing #AWS2-1, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating shielded metal arc welding equipment.
7. Visually inspect trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS AWS2-1-SMAW or ANSI/AWS B2.1-8-023 and Drawing #AWS2-1.
11. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2-1.

NOTE: **1. Use of stainless steel plate for workmanship qualification is optional. The workmanship qualification test related to drawing #AWS2-1 (refer to figure 2 of this guide) may be delivered at the end of stainless steel electrode training for SMAW or at the end of the program.**

2. Workmanship Qualification is mandatory for Level II-Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #8 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.1 *SMAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

LEARNING OBJECTIVE #9: Make fillet welds, all positions, on carbon steel pipe.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E6010 or E6011, and E7018 electrodes, base metal or an assembly, shop equipment or tools, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on carbon steel pipe.

EVALUATION CRITERIA: The trainee produces sound fillet welds, in all positions, on carbon steel pipe. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat, rotated) position and ending with the 6F (multiple, inclined) position. The objective is practiced on a routine basis during the shielded metal arc welding portion of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on carbon steel pipe.
2. Provide instruction related to visual examination and repair of fillet welds on pipe, produced with the shielded metal arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using E6010 or E6011, and E7018 electrodes.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating shielded metal arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship related to this learning objective.
13. Keep training records reflecting results of all position fillet welding, on carbon steel pipe.

LEARNING OBJECTIVE #10: Make 2G, 5G and 6G groove welds, on carbon steel pipe.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E6010 or E6011, and E7018 electrodes, base metal or an assembly, shop equipment or tools, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G, 5G and 6G groove welds, with or without backing on carbon steel pipe.

EVALUATION CRITERIA: The trainee produces sound groove welds, in the 2G, 5G and 6G positions, with or without backing, on carbon steel pipe. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined, bend tested and accepted by the instructor. The objective is practiced in individual stages, beginning with 2G (horizontal), followed by 5G (multiple) and ending with the 6G (multiple) position.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding, with or without backing on carbon steel pipe.
2. Provide instruction related to visual examination, repair and bend testing of groove welds on pipe, produced with the shielded metal arc welding process.
3. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on carbon steel pipe, with or without backing, using E6010 or E6011, and E7018 electrodes.
4. Provide training exercises related to 5G (multiple), single and multiple pass groove welding, on carbon steel pipe, with or without backing, using E6010 or E6011, and E7018 electrodes.
5. Provide training exercises related to 6G (multiple), single and multiple pass groove welding, on carbon steel pipe, with or without backing, using E6010 or E6011, and E7018 electrodes.
6. Observe trainee following safe arc welding practices.
7. Observe trainee operating shielded metal arc welding equipment.
8. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
9. Visually inspect and bend test trainee's workmanship samples.
10. Provide instruction in welding procedures and performance qualification related to this learning objective.
11. Keep training records reflecting results of 2G, 5G and 6G groove welding, on carbon steel pipe.

LEARNING OBJECTIVE #11: Perform a 6G limited thickness qualification test on carbon steel pipe, with or without backing, using the shielded metal arc welding process.

PERFORMANCE CONDITIONS: Provided with protective clothing and equipment, shielded metal arc welding equipment, accessories, E6010 or E6011, and E7018 electrodes, 6" or 8" Ø Schedule 80 carbon steel pipe, Welding Procedure Specification ANSI/AWS B2.1-1-016 or ANSI/AWS B2.1-1-022, Drawing #AWS2-6 (figure 7), and shop equipment or tools, in the work area, with no assistance from the instructor,

DESIRED BEHAVIOR: the trainee will perform welder performance qualification testing.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 6G (multiple) position. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1-1-016 or ANSI/AWS B2.1-1-022, and Drawing #AWS2-6, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of performance qualification for visual examination and bend testing.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and performance qualification related to this learning objective.
2. Provide instruction in visual examination and bend testing requirements for performance qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the performance qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the performance qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating shielded metal arc welding equipment.
7. Visually inspect and bend test the trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of performance qualification for visual examination and bend testing.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1-1-016 or ANSI/AWS B2.1-1-022 and Drawing #AWS2-6.
11. Keep training records reflecting results of performance qualification testing for Drawing #AWS2-6.

NOTE: 1. Performance Qualification is mandatory for Level II-Advanced Welder Qualification. However, Performance Qualification for Learning Objective #11 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.1 *SMAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform a duplicate performance qualification test for this learning objective.

3.3.6.2 UNIT #2: GAS METAL ARC WELDING (GMAW–S, GMAW)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a single or mixed shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of gas metal arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide a safety tour and orientation for gas metal arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I – General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of GMAW safe practices training.

LEARNING OBJECTIVE #2: Make minor external repairs to gas metal arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to gas metal arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: Repairs to gas metal arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas metal arc welding component identification portion of a closed book written examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding component identification
3. Provide demonstrations related to shielding gas equipment and accessory component identification.
4. Provide instruction related to gas metal arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on gas metal arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to gas metal arc welding equipment and accessories.
9. Provide instruction related to minor external repairs to shielding gas equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to gas metal arc welding, shielding gas equipment and accessory component identification.
15. Prepare trainee for the gas metal arc welding component identification portion of a closed book written examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.
16. Keep training records reflecting results of gas metal arc welding, shielding gas equipment, and accessory component identification.

LEARNING OBJECTIVE #3: Set up for gas metal arc welding operations on aluminum and carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a mixed or single shielding gas supply with equipment and accessories, E4043, E70S–X electrodes, and base metal, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform gas metal arc welding operations on carbon steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Gas metal arc welding equipment is set up and adjusted to the proper voltage, wire feed speed, and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas metal arc welding principles of operation, and filler metal identification/selection portion of a closed book written examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, and ANSI/AWS A5.10, *Specification for Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in gas metal arc welding principles of operation.
5. Provide instruction in shielding gases relevant to the gas metal arc welding process.
6. Provide instruction in gas metal arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up gas metal arc welding equipment and accessories.
9. Provide trainee with practice setting up shielding gas equipment and accessories.
10. Observe trainee following safe practices.
11. Observe trainee using proper terms and definitions.
12. Observe trainee setting up gas metal arc welding equipment and accessories.
13. Observe trainee setting up shielding gas equipment and accessories.
14. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation, filler metal classification and selection.

15. Prepare trainee for the gas metal arc welding principles of operation, and filler metal identification/selection portion of a closed book written examination from the related sections of ANSI/AWS C5.6 *Recommended Practices for Gas Metal Arc Welding*, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, and ANSI/AWS A5.10, *Specification for Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes*.
16. Keep training records reflecting results of gas metal arc welding equipment set up, principles of operation, and filler metal identification/selection.

LEARNING OBJECTIVE #4: Operate gas metal arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 100 % argon shielding gas with equipment and accessories, 3/64 or 1/16 E4043 or E5XXX, .035 E70S–X electrodes, base metal, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform short circuit and spray transfer gas metal arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas metal arc principles of operation and common process variables portion of a closed book written examination from the related section of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding equipment operations.
3. Provide instruction related to gas metal arc welding principles of operation.
4. Provide instruction related to common process variables for gas metal arc welding.
5. Provide training exercises related to gas metal arc welding equipment operation.
7. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on aluminum plate, using spray transfer, 3/64 or 1/16 diameter E4043 or E5XXX electrodes and a 100% argon shielding gas.
8. Provide training exercises related to multiple pass, multi-directional, surfacing welds, on carbon steel pipe in the multiple fixed position, using short circuiting transfer, .035 diameter E70S–X electrodes and a 75% argon/25% CO_2 shielding gas.
9. Observe trainee following safe arc welding practices.
10. Observe trainee operating gas metal arc welding equipment.
11. Visually inspect trainee's workmanship samples.
12. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation and common process variables.
13. Prepare trainee for the gas metal arc welding principles of operation and common process variables portion of a closed book written examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.
14. Keep training records reflecting results of gas metal arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5: Execute corrective action to repair surface flaws on welds and base metals.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, gas metal arc welding equipment and accessories, shop equipment or tools, prepared base metals or an assembly, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will take corrective actions to repair surface flaws in welds or on base metals.

EVALUATION CRITERIA: The trainee's workmanship sample is free of base metal and weld metal surface flaws. The workmanship sample meets the design and welding specifications of the welding assignment. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced on an as required basis during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to the repair of surface flaws on the prepared edges and surfaces of base metals using the GMAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
2. Provide instruction related to the repair of visible surface flaws in weld metal using the GMAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
3. Provide demonstrations related to the repair of surface flaws on the prepared edges and surfaces of base metals using the GMAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
4. Provide demonstrations related to the repair of visible surface flaws in weld metal using the GMAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
5. Require the trainee to repair surface flaws on the prepared edges and surfaces of base metals.
6. Require the trainee to repair visible surface flaws in weld metal.
7. Require the trainee to notify the instructor of all repairs to surface flaws on the prepared edges and surfaces of base metals.
8. Require the trainee to notify the instructor of all repairs to visible surface flaws in weld metal.
9. Observe trainee making repairs.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to corrective actions for the repair of surface flaws in welds or base metal surfaces.
12. Keep training records reflecting the results of corrective actions for the repair of surface flaws in welds or base metal surfaces training.

LEARNING OBJECTIVE #6: Make fillet welds, all positions, on aluminum plate.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 100% argon shielding gas supply with equipment and accessories, 3/64 or 1/16 diameter E4043 or E5XXX electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on aluminum in all positions using spray transfer.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding of aluminum using spray transfer.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas metal arc welding equipment.
9. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
10. Visually inspect trainee's workmanship samples.
11. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
12. Keep training records reflecting results of all position aluminum fillet welding.

LEARNING OBJECTIVE #7: Make groove welds, all positions, on aluminum, using the gas metal arc welding process, with spray transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 100% argon shielding gas supply with equipment and accessories, 3/64 or 1/16 diameter E4043 or E5XXX electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on aluminum in all positions using spray transfer.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding of aluminum using spray transfer.
2. Provide instruction related to visual examination and repair of groove welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass groove welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
4. Provide training exercises related to 2F (horizontal), single and multiple pass groove welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
5. Provide training exercises related to 3F (vertical up), single and multiple pass groove welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
6. Provide training exercises related to 4F (overhead), single and multiple pass groove welding, on aluminum, using spray transfer, E4043 or E5XXX electrodes, and applicable shielding gas.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas metal arc welding equipment.
9. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
10. Visually inspect trainee's workmanship samples.
11. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
12. Keep training records reflecting results of all position aluminum groove welding.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 10.**

LEARNING OBJECTIVE #8: Perform an all position workmanship qualification test, on aluminum plate.

PERFORMANCE CONDITIONS: Provided with protective clothing and equipment, gas metal arc welding equipment, accessories, a 100% argon shielding gas supply with equipment and accessories, 3/64 or 1/16 diameter E4043 or E5XXX electrodes, base metals, Welding Procedure Specification AWS2-1-GMAW or AWS2-1.1-GMAW, Drawing #AWS2-2 (figure 3), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds all positions using aluminum electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS AWS2-1-GMAW or AWS2-1.1-GMAW and Drawing #AWS2-2, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas metal arc welding equipment.
7. Visually inspect trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS AWS2-1-GMAW or AWS2-1.1-GMAW and Drawing #AWS2-2.
11. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2-2.

NOTE: **1. The workmanship qualification test related to drawing #AWS2-2 (refer to figure 3 of this guide) may be delivered at the end of training for GMAW aluminum welding or at the end of the program.**

2. Workmanship Qualification is mandatory for Level II-Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #8 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.2 *GMAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

LEARNING OBJECTIVE #9: Make fillet welds in the 2F position on carbon steel pipe, using spray transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, an argon/2%-5% oxygen shielding gas supply with equipment and accessories, .035 or .045 diameter E70S–X electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on carbon steel pipe, in the 2F (horizontal) position, using spray transfer.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the horizontal position. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in the 2F (horizontal) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related 2F fillet welding of carbon steel pipe using spray transfer.
2. Provide instruction related to visual examination of fillet welds produced with the gas metal arc welding process.
3. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel pipe, using spray transfer, an argon/2%-5% oxygen shielding gas supply and .035 or .045 diameter E70S–X electrodes.
4. Observe trainee following safe arc welding practices.
5. Observe trainee operating gas metal arc welding equipment.
6. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
7. Visually inspect trainee's workmanship samples.
8. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
9. Keep training records reflecting results of horizontal fillet welding of carbon steel pipe using spray transfer.

LEARNING OBJECTIVE #10: Make fillet welds, all positions, on carbon steel pipe, using short circuiting transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 75% argon/25% CO_2 shielding gas supply with equipment and accessories, .035 or .045 diameter E70S–X electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds, all positions, on carbon steel pipe, using short circuiting transfer.

EVALUATION CRITERIA: The trainee produces sound welds all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat, rotated) position and ending with the 6F (multiple, inclined) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on carbon steel pipe using short circuiting transfer.
2. Provide instruction related to visual examination and repair of fillet welds on pipe, produced with the gas metal arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating gas metal arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship related to this learning objective.
13. Keep training records reflecting results of all position fillet welding, on carbon steel pipe, using short circuiting transfer.

LEARNING OBJECTIVE #11: Make 2G and 5G groove welds, on carbon steel pipe, using short circuiting transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 75% argon/25% CO_2 shielding gas supply with equipment and accessories, .035 or .045 diameter E70S–X electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G and 5G groove welds on carbon steel pipe, using short circuiting transfer.

EVALUATION CRITERIA: The trainee produces sound groove welds, in the 2G and 5G positions, on carbon steel pipe, using short circuiting transfer. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined, and accepted by the instructor. The objective is practiced in individual stages, beginning with 2G (horizontal) and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G and 5G groove welding on carbon steel pipe, using short circuiting transfer.
2. Provide instruction related to visual examination, repair and bend testing of groove welds on pipe, produced with the gas metal arc welding process.
3. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
4. Provide training exercises related to 5G (multiple), single and multiple pass groove welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas supply and accessories .035 or .045 diameter E70S–X electrodes.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas metal arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding, on carbon steel pipe, using short circuiting transfer.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #12: Perform a combination workmanship qualification test on carbon steel plate and pipe.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a 75% argon/25% CO_2 and % argon/2%-5% oxygen shielding gas supply with equipment and accessories, an .035 diameter E70S–X electrode, base metals, Welding Procedure Specifications AWS2–2–GMAW and AWS2–3–GMAW, Drawing #AWS2–3 (figure 4), and hand tools, in the work area, with no assistance from the instructor,

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds on carbon steel pipe and plate using a 75% argon/25% CO_2 and % argon/2%-5% oxygen shielding gas supply and an .035 diameter E70S–X electrode. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS AWS2–2–GMAW, WPS AWS2–3–GMAW and Drawing #AWS2–3, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas metal arc welding equipment.
7. Visually inspect trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS AWS2–2–GMAW, WPS AWS2–3–GMAW and Drawing #AWS2–3.
11. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2–3.

NOTE: 1. The workmanship qualification test related to drawing #AWS2–3 (refer to figure 4 of this guide) may be delivered at the end of training for GMAW carbon steel pipe welding or at the end of the program.

2. Workmanship Qualification is mandatory for Level II–Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #12 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.2 *GMAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

3.3.6.3 UNIT #3: FLUX CORED ARC WELDING (FCAW-S, FCAW-G)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of flux cored arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide a safety tour and orientation for flux cored arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I – General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.
13. Keep records reflecting successful completion of FCAW safe practices training.

LEARNING OBJECTIVE #2: Make minor external repairs to flux cored arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to flux cored arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs to flux cored arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment, or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the flux cored arc welding component identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding component identification.
3. Provide demonstrations related to shielding gas equipment and accessory component identification.

4. Provide instruction related to flux cored arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on flux cored arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to flux cored arc welding equipment and accessories.
9. Provide instruction related to minor external repairs to shielding gas equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to flux cored arc welding, shielding gas equipment, and accessory component identification.
15. Prepare trainee for the flux cored arc welding component identification portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.
16. Keep training records reflecting results of flux cored arc welding, shielding gas equipment and accessory component identification.

LEARNING OBJECTIVE #3: Set up for flux cored arc welding operations on carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, a mixed or single shielding gas supply (when required) with equipment and accessories, E71T-1 or E71T-11 electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform self-shielded and gas-shielded flux cored arc welding operations on carbon steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Flux cored arc welding equipment is set up and adjusted to the proper voltage, wire feed speed, and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the flux cored arc welding principles of operation, and filler metal identification/selection portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes* and ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in flux cored arc welding principles of operation.
5. Provide instruction in shielding gases for gas-shielded flux cored arc welding.
6. Provide instruction in the flux cored arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up flux cored arc welding equipment and accessories.
9. Provide trainee with practice setting up shielding gas equipment and accessories.
10. Observe trainee following safe practices.
11. Observe trainee using proper terms and definitions.
12. Observe trainee setting up flux cored arc welding equipment and accessories.
13. Observe trainee setting up shielding gas equipment and accessories.
14. Develop and administer formative or diagnostic tests relevant to flux cored arc welding principles of operation and filler metal identification and selection.
15. Prepare trainee for the flux cored arc welding principles of operation, and filler metal identification/selection portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes* and ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*.
16. Keep training records reflecting results of flux cored arc welding equipment set up, principles of operation, and filler metal identification/selection.

LEARNING OBJECTIVE #4: Operate flux cored arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, 75% argon/25% CO_2 shielding gas with equipment and accessories (when required), .035 or .045 diameter E71T–1 (gas-shielded) and E71T–11 (self-shielded) electrodes, base metals, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will perform self-shielded and gas-shielded flux cored arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the flux cored arc welding principles of operation and common process variables portion of a closed book written examination from the related section of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding equipment operations.
3. Provide instruction related to flux cored arc welding principles of operation.
4. Provide instruction related to common process variables for flux cored arc welding.
8. Provide training exercises related to multiple pass, multi-directional, surfacing welds, on carbon steel pipe in the multiple fixed position, using .035 or .045 diameter E71T–11 (self-shielded) electrode.
9. Provide training exercises related to multiple pass, multi-directional, surfacing welds, on carbon steel pipe in the multiple fixed position, using E71T–1 (gas-shielded) electrodes, and 75% argon/25% CO_2 shielding gas.
10. Observe trainee following safe arc welding practices.
11. Observe trainee operating flux cored arc welding equipment.
12. Visually inspect trainee's workmanship samples.
13. Develop and administer formative or diagnostic tests relevant to flux cored arc welding principles of operation and common process variables.
14. Prepare trainee for the flux cored arc welding principles of operation and common process variables portion of a closed book written examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*
15. Keep training records reflecting results of flux cored arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5: Execute corrective action to repair surface flaws on welds and base metals.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, flux cored arc welding equipment and accessories, shop equipment or tools, prepared base metals or an assembly, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will take corrective actions to repair surface flaws in welds or on base metals.

EVALUATION CRITERIA: The trainee's workmanship sample is free of base metal and weld metal surface flaws. The workmanship sample meets the design and welding specifications of the welding assignment. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced on an as required basis during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to the repair of surface flaws on the prepared edges and surfaces of base metals using the FCAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
2. Provide instruction related to the repair of visible surface flaws in weld metal using the FCAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
3. Provide demonstrations related to the repair of surface flaws on the prepared edges and surfaces of base metals using the FCAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
4. Provide demonstrations related to the repair of visible surface flaws in weld metal using the FCAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
5. Require the trainee to repair surface flaws on the prepared edges and surfaces of base metals.
6. Require the trainee to repair visible surface flaws in weld metal.
7. Require the trainee to notify the instructor of all repairs to surface flaws on the prepared edges and surfaces of base metals.
8. Require the trainee to notify the instructor of all repairs to visible surface flaws in weld metal.
9. Observe trainee making repairs.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to corrective actions for the repair of surface flaws in welds or base metal surfaces.
12. Keep training records reflecting the results of corrective actions for the repair of surface flaws in welds or base metal surfaces training.

LEARNING OBJECTIVE #6: Make fillet welds, all positions, on carbon steel pipe, using self-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, .035 or .045 diameter E71T-11 (self-shielded) electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds, all positions, on carbon steel pipe, using self-shielded electrodes.

EVALUATION CRITERIA: The trainee produces sound welds all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat, rotated) position and ending with the 6F (multiple, inclined) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on carbon steel pipe; using .035 or .045 diameter E71T-11 electrode.
2. Provide instruction related to visual examination and repair of fillet welds on pipe, produced with the flux cored arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on carbon steel pipe, using .035 or .045 diameter E71T-11 electrode.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel pipe, using .035 or .045 diameter E71T-11 electrode.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel pipe, using .035 or .045 diameter E71T-11 electrode.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using .035 or .045 diameter E71T-11 electrode.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using .035 or .045 diameter E71T-11 electrode.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating flux cored arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship related to this learning objective.
13. Keep training records reflecting results of all position fillet welding, on carbon steel pipe, using self-shielded electrodes.

LEARNING OBJECTIVE #7: Make 2G and 5G groove welds, on carbon steel pipe, using self-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, .035 or .045 diameter E71T–11 (self-shielded) electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G and 5G groove welds on carbon steel pipe, using self-shielded electrodes.

EVALUATION CRITERIA: The trainee produces sound groove welds, in the 2G and 5G positions, on carbon steel pipe, using self-shielded electrodes. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with 2G (horizontal) and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G and 5G groove welding, on carbon steel pipe, using .035 or .045 diameter E71T–11 electrode.
2. Provide instruction related to visual examination and repair of groove welds on pipe, produced with the flux cored arc welding process.
3. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on carbon steel pipe, using .035 or .045 diameter E71T–11 electrode.
4. Provide training exercises related to 5G (multiple), single and multiple pass groove welding, on carbon steel pipe, using .035 or .045 diameter E71T–11 electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating flux cored arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and performance qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding, on carbon steel pipe, using self-shielded electrodes.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #8: Make fillet welds, all positions, on carbon steel pipe, using gas-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, 75% argon/25% CO_2 shielding gas with equipment and accessories, .035 or .045 diameter E71T–1 (gas-shielded) electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds in all positions, on carbon steel pipe using gas-shielded electrodes.

EVALUATION CRITERIA: The trainee produces sound welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat, rotated) position and ending with the 6F (multiple, inclined) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
2. Provide instruction related to visual examination and repair of fillet welds on pipe, produced with the flux cored arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating flux cored arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship related to this learning objective.
13. Keep training records reflecting results of all position fillet welding, on carbon steel pipe, using gas-shielded electrodes.

LEARNING OBJECTIVE #9: Make 2G and 5G groove welds, on carbon steel pipe, using gas-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, 75% argon/25% CO_2 shielding gas with equipment and accessories, .035 or .045 diameter E71T–1 (gas shielded) electrode, base metals and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G and 5G groove welds on carbon steel pipe using gas-shielded electrodes.

EVALUATION CRITERIA: The trainee produces sound groove welds, in the 2G and 5G positions, on carbon steel pipe, using gas-shielded electrodes. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with 2G (horizontal) and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel pipe groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G and 5G groove welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
2. Provide instruction related to visual examination, repair and bend testing of groove welds on pipe, produced with the flux cored arc welding process.
3. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on carbon steel pipe, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
4. Provide training exercises related to 5G (multiple), single and multiple pass groove welding, on carbon steel pipe, using a 75% argon/25% CO_2 shielding gas, and .035 or .045 diameter E71T–1 electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating flux cored arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding, on carbon steel pipe, using gas-shielded electrodes.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #10: Perform a combination workmanship qualification test on carbon steel plate and pipe.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, a 75% argon/25% CO_2 or CO_2 shielding gas supply (as required) with equipment and accessories, .035 or .045 diameter E71T–1 (gas-shielded) and E71T–11 (self-shielded) electrodes, base metals, Welding Procedure Specifications ANSI/AWS B2.1.019 or ANSI/AWS B2.1.020 and ANSI/AWS B2.1–1–027, Drawing #AWS2–4 (figure 5), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds on carbon steel pipe and plate, using a 75% argon/25% CO_2 or CO_2 shielding gas supply (when required) and .035 or .045 diameter E71T–1 (gas shielded) and E71T–11 (self-shielded) electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.019 or ANSI/AWS B2.1.020 and ANSI/AWS B2.1–1–027, and Drawing #AWS2–4, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating flux cored arc welding equipment.
7. Visually inspect trainee's workmanship sample.
8. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
9. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.019 or ANSI/AWS B2.1.020 and ANSI/AWS B2.1–1–027 and Drawing #AWS2–4.
10. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2–4.

NOTE: 1. **The workmanship qualification test related to drawing #AWS2–4 (refer to figure 5 of this guide) may be delivered at the end of training for FCAW carbon steel pipe welding or at the end of the program.**

2. **Workmanship Qualification is mandatory for Level II–Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #10 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.3 *FCAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.**

3.3.6.4 UNIT #4: GAS TUNGSTEN ARC WELDING (GTAW)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, a shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of gas tungsten arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide a safety tour and orientation for gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II – Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I – General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a closed book written examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.
13. Keep records reflecting successful completion of GTAW safe practices training.

LEARNING OBJECTIVE #2: Make minor external repairs to gas tungsten arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction, demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas tungsten arc welding component identification portion of a closed book written examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 1, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding component identification.
3. Provide demonstrations related to shielding gas equipment and accessory component identification.
4. Provide instruction related to gas tungsten arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on gas tungsten arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to gas tungsten arc welding equipment and accessories.
9. Introduce related terms and definitions
10. Provide trainee with repair assignments when required.
11. Observe trainee following safe repair practices.
12. Observe trainee using proper terms and definitions.
13. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding shielding gas equipment, and accessory component identification.
14. Prepare trainee for the gas tungsten arc welding component identification portion of a closed book written examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes*.
15. Keep training records reflecting results of gas tungsten arc welding, shielding gas equipment and accessory component identification.

LEARNING OBJECTIVE #3: Set up for gas tungsten arc welding operations on carbon steel, aluminum and stainless steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, argon shielding gas supply with equipment and accessories, ER70S–X (carbon steel), ER3XX (stainless steel) and ER4043 or ER5XXX (aluminum) filler metals, appropriate tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform gas tungsten arc welding operations on carbon steel, aluminum and stainless steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Gas tungsten arc welding equipment is set up and adjusted to the proper current and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas tungsten arc welding principles of operation, tungsten electrode and base/filler metal identification/selection portion of a closed book written examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding*, AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes*, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, ANSI/AWS A5.9, *Specification for Bare Stainless Steel Welding Electrodes and Rods*, ANSI/AWS A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*, ANSI/AWS A5.12, *Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting* and AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in gas tungsten arc welding principles of operation.
5. Provide instruction in shielding gases as related to the gas tungsten arc welding process.
6. Provide instruction in aluminum and stainless steel shapes, and identification/selection.
7. Provide instruction in tungsten electrode identification/selection for carbon steel, aluminum and stainless steel.
8. Provide instruction in the gas tungsten arc welding filler metal identification/selection for carbon steel, aluminum, and stainless steel.
9. Introduce related terms and definitions.
10. Provide trainee with practice setting up gas tungsten arc welding equipment and accessories.
11. Provide trainee with practice setting up shielding gas equipment and accessories.
12. Observe trainee following safe practices.

13. Observe trainee using proper terms and definitions.
14. Observe trainee setting up gas tungsten arc welding equipment and accessories.
15. Observe trainee setting up shielding gas equipment and accessories.
16. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding principles of operation, tungsten electrode identification/selection, and base/filler metal identification/selection.
17. Prepare trainee for the gas tungsten arc welding principles of operation, aluminum and stainless steel weldability, and filler metal classification portion of a closed book written examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding*, AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Chapter 4, Welding Metallurgy, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, ANSI/AWS A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*, ANSI/AWS A5.9, *Specification for Bare Stainless Steel Electrodes and Rods* and ANSI/AWS A5.12, *Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting*.
18. Keep training records reflecting results of gas tungsten arc welding equipment set up, principles of operation, tungsten electrode identification/selection, and base/filler metal identification/selection.

LEARNING OBJECTIVE #4: Operate gas tungsten arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S–X (carbon steel), ER3XX (stainless steel) and ER4043 or ER5XXX (aluminum) filler metals, appropriate tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will perform gas tungsten arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds were visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC11, the trainee shall pass the gas tungsten arc welding principles of operation and common process variables portion of a closed book written examination from the related section of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding equipment operations.
3. Provide instruction related to gas tungsten arc welding principles of operation.
4. Provide instruction related to common process variables for gas tungsten arc welding.
5. Provide training exercises related to gas tungsten arc welding equipment operation.
9. Provide training exercises related to multi-pass surfacing welds in the multiple fixed position on carbon steel round tubing, using applicable filler metal, an EWTh–2 or EWCe–2 electrode, and shielding gas.
10. Provide training exercises related to vertical up, single pass, surfacing welds, on aluminum sheet, using applicable filler metal, an EWP or EWZr electrode, and shielding gas.
11. Provide training exercises related to overhead, single pass, surfacing welds, on stainless steel sheet, using applicable filler metal, an EWTh–2 or EWCe–2 electrode, and shielding gas.
12. Observe trainee following safe arc welding practices.
13. Observe trainee operating gas tungsten arc welding equipment.
14. Visually inspect trainee's workmanship samples.
15. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding principles of operation and common process variables.
16. Prepare trainee for the gas tungsten arc welding principles of operation and common process variables portion of a closed book written examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes*.
17. Keep training records reflecting results of gas tungsten arc welding equipment principles of operation, common process variables, and performance exercises.

LEARNING OBJECTIVE #5: Execute corrective action to repair surface flaws on welds and base metals.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, gas tungsten arc welding equipment and accessories, shop equipment or tools, prepared base metals or an assembly, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will take corrective actions to repair surface flaws in welds or on base metals.

EVALUATION CRITERIA: The trainee's workmanship sample is free of base metal and weld metal surface flaws. The workmanship sample meets the design and welding specifications of the welding assignment. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced on an as required basis during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction related to the repair of surface flaws on the prepared edges and surfaces of base metals using the GTAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
2. Provide instruction related to the repair of visible surface flaws in weld metal using the GTAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
3. Provide demonstrations related to the repair of surface flaws on the prepared edges and surfaces of base metals using the GTAW process and appropriate shop equipment or tools. (e.g. correction to thickness caused by excessive grinding, or gouges in oxyfuel and arc cut edges or surfaces)
4. Provide demonstrations related to the repair of visible surface flaws in weld metal using the GTAW process and appropriate shop equipment or tools. (e.g. correction of weld size, slag, undercut, porosity, surface cracks, underfill, overlap, etc.)
5. Require the trainee to repair surface flaws on the prepared edges and surfaces of base metals.
6. Require the trainee to repair visible surface flaws in weld metal.
7. Require the trainee to notify the instructor of all repairs to surface flaws on the prepared edges and surfaces of base metals.
8. Require the trainee to notify the instructor of all repairs to visible surface flaws in weld metal.
9. Observe trainee making repairs.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to corrective actions for the repair of surface flaws in welds or base metal surfaces.
12. Keep training records reflecting the results of corrective actions for the repair of surface flaws in welds or base metal surfaces training.

LEARNING OBJECTIVE #6: Make 3F – 4F fillet welds, on aluminum sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 or ER5XXX (aluminum) filler metals, EWP or EWZr tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on aluminum in the 3F (vertical up) and 4F (overhead) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the 3F (vertical up) and 4F (overhead) positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 3F (vertical up) position and ending with the 4F (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 3F (vertical up) and 4F (overhead) position fillet welding.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 3F (vertical up) fillet welding, on aluminum sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
4. Provide training exercises related to 4F (overhead) fillet welding, on aluminum sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 3F – 4F fillet welding on aluminum sheet.

LEARNING OBJECTIVE #7: Make 2G – 4G groove welds, on aluminum sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 or ER5XXX (aluminum) filler metals, EWP or EWZr tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on aluminum sheet in the 2G (horizontal) through 4G (overhead) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 2G (horizontal) through 4G (overhead) positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages, beginning with the 2G (horizontal) position and ending with the 4G (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G (horizontal) through 4G (overhead) position groove welding.
2. Provide instruction related to visual examination and repair of of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 2G (horizontal) groove welding on aluminum sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
4. Provide training exercises related to 3G (vertical up) groove welding on aluminum sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
5. Provide training exercises related to 4G (overhead) groove welding on aluminum sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
6. Observe trainee following safe arc welding practices.
7. Observe trainee operating gas tungsten arc welding equipment.
8. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Keep training records reflecting results of 2G – 4G groove welding on aluminum sheet.

LEARNING OBJECTIVE #8: Make 4F fillet welds, on stainless steel sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on stainless steel in the 4F (overhead) position using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the 4F (overhead) position. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in the 4F (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 4F (position) position fillet welding.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 4F (overhead), fillet welding on stainless steel, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
4. Observe trainee following safe arc welding practices.
5. Observe trainee operating gas tungsten arc welding equipment.
6. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
7. Visually inspect trainee's workmanship samples.
8. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
9. Keep training records reflecting results of 4F fillet welding on stainless steel sheet.

LEARNING OBJECTIVE #9: Make 3G – 4G groove welds, on stainless steel sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on stainless steel in the 3G (vertical up) and 4G (overhead) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: Sound groove welds are produced in the 3G (vertical up) and 4G (overhead) positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 3G (vertical up) position and ending with the 4G (overhead) position. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 3G (vertical up) and 4G (overhead) position groove welding.
2. Provide instruction related to visual examination and repair of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 3G (vertical up) groove welding on stainless steel sheet, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
4. Provide training exercises related to 4G (overhead) groove welding on stainless steel sheet, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 3G – 4G groove welding on stainless steel sheet.

LEARNING OBJECTIVE #10: Make fillet welds, all positions, on carbon steel round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S–X (carbon steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds all positions on carbon steel round tubing.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 1F (flat, rotated) position and ending with the 6F (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel round tubing fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on carbon steel round tubing.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on carbon steel tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on carbon steel tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on carbon steel tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on carbon steel tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on carbon steel tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating gas tungsten arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
13. Keep training records reflecting results of all position fillet welding on carbon steel round tubing.

LEARNING OBJECTIVE #11: Make fillet welds, all positions, on aluminum round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 or ER5XXX (aluminum) filler metals, EWP or EWZr tungsten electrodes tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds all positions on aluminum round tubing.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 1F (flat, rotated) position and ending with the 6F (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum round tubing fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on aluminum round tubing.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on aluminum tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on aluminum tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on aluminum tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on aluminum tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on aluminum tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating gas tungsten arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
13. Keep training records reflecting results of all position fillet welding on aluminum round tubing.

LEARNING OBJECTIVE #12: Make fillet welds, all positions, on stainless steel round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds all positions on stainless steel round tubing.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 1F (flat, rotated) position and ending with the 6F (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel round tubing fillet welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding on stainless steel round tubing.
2. Provide instruction related to visual examination and repair of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat, rotated), single and multiple pass fillet welding, on stainless steel tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on stainless steel tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
5. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on stainless steel tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
6. Provide training exercises related to 5F (multiple), single and multiple pass fillet welding, on stainless steel tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
7. Provide training exercises related to 6F (multiple), single and multiple pass fillet welding, on stainless steel tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating gas tungsten arc welding equipment.
10. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
11. Visually inspect trainee's workmanship samples.
12. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
13. Keep training records reflecting results of all position fillet welding on stainless steel round tubing.

LEARNING OBJECTIVE #13: Make 2G and 5G groove welds, on carbon steel round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S–X (carbon steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G (horizontal) and 5G (multiple) groove welds on carbon steel round tubing.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 2G (horizontal) and 5G (multiple) positions on carbon steel round tubing. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 2G (horizontal) position and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the carbon steel round tubing groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G (horizontal) and 5G (multiple) groove welding on carbon steel round tubing.
2. Provide instruction related to visual examination and repair of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 2G (horizontal), groove welding, on carbon steel round tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
4. Provide training exercises related to 5G (multiple), groove welding, on carbon steel round tubing, using an argon shielding gas supply, ER70S–X (carbon steel) filler metals and EWTh–2 or EWCe–2 tungsten electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding on carbon steel round tubing.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #14: Make 2G and 5G groove welds, on aluminum round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 or ER5XXX (aluminum) filler metals, EWP or EWZr tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G (horizontal) and 5G (multiple) groove welds on aluminum round tubing.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 2G (horizontal) and 5G (multiple) positions on aluminum round tubing. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 2G (horizontal) position and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the aluminum round tubing groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G (horizontal) and 5G (multiple) groove welding on aluminum round tubing.
2. Provide instruction related to visual examination and repair of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 2G (horizontal), groove welding, on aluminum round tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
4. Provide training exercises related to 5G (multiple), groove welding, on aluminum round tubing, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metals and EWP or EWZr tungsten electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding on aluminum round tubing.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #15: Make 2G and 5G groove welds, on stainless steel round tubing.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make 2G (horizontal) and 5G (multiple) groove welds on stainless steel round tubing.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 2G (horizontal) and 5G (multiple) positions on stainless steel round tubing. During and after each welding operation, welds are visually examined by the welder and corrective actions taken to repair unfavorable conditions. The trainee reports corrective actions to the instructor. The completed assignment is visually examined and accepted by the instructor. The objective is practiced in individual stages beginning with the 2G (horizontal) position and ending with the 5G (multiple) position. In accordance with the requirements of AWS QC11, the trainee shall pass the stainless steel round tubing groove welding element of a workmanship qualification test [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 2G (horizontal) and 5G (multiple) groove welding on stainless steel round tubing.
2. Provide instruction related to visual examination and repair of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 2G (horizontal), groove welding, on stainless steel round tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh-2 or EWCe-2 tungsten electrode.
4. Provide training exercises related to 5G (multiple), groove welding, on stainless steel round tubing, using an argon shielding gas supply, ER3XX (stainless steel) filler metals and EWTh-2 or EWCe-2 tungsten electrode.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Observe trainee taking corrective actions to repair surface flaws in base or weld metal.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Keep training records reflecting results of 2G and 5G groove welding on stainless steel round tubing.

NOTE: **When the QC7 option outlined in section 4 of this guide is used, bend testing of groove welds shall be included in learning activity 8.**

LEARNING OBJECTIVE #16: Perform a combination workmanship qualification test on carbon steel round tubing and sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S–X (carbon steel) filler metals, EWTh–2 or EWCe–2 tungsten electrodes, base metals, Welding Procedure Specification ANSI/AWS B2.1.008, Drawing #AWS2–5 (figure 6), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds on carbon steel round tubing and sheet, using an argon shielding gas supply, E70S–X (carbon steel) filler metal and EWTh–2 or EWCe–2 tungsten electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.008 and Drawing #AWS2–5, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Visually inspect trainee's workmanship sample.
8. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
9. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.008 and Drawing #AWS2–5.
10. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2–5.

NOTE: **1. The workmanship qualification test related to drawing #AWS2–5 (refer to figure 6 of this guide) may be delivered at the end of training for GTAW of carbon steel round tubing, or at the end of the program.**

2. Workmanship Qualification is mandatory for Level II–Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #16 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.4 *GTAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

LEARNING OBJECTIVE #17: Perform a combination workmanship qualification test on aluminum round tubing and sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 or ER5XXX (aluminum) filler metals, EWP or EWZr tungsten electrodes, base metals, Welding Procedure Specifications AWS2-1-GTAW or AWS2-1.1-GTAW Drawing #AWS2–5 (figure 6), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds on aluminum round tubing and sheet, using an argon shielding gas supply, ER4043 or ER5XXX (aluminum) filler metal and EWP or EWZr tungsten electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS AWS2-1-GTAW or WPS AWS2-1.1-GTAW and Drawing #AWS2–5, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification testing [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Visually inspect trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS AWS2-1-GTAW or WPS AWS2-1.1-GTAW and Drawing #AWS2–5.
11. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2–5.

NOTE: **1. The workmanship qualification test related to drawing #AWS2–5 (refer to figure 6 of this guide) may be delivered at the end of training for GTAW of aluminum round tubing, or at the end of the program.**

2. Workmanship Qualification is mandatory for Level II–Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #17 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.4 *GTAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

LEARNING OBJECTIVE #18: Perform a combination workmanship qualification test on stainless steel round tubing and sheet.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, base metals, Welding Procedure Specification ANSI/AWS B2.1.009, Drawing #AWS2-5 (figure 6), and hand tools, in the work area, with no assistance from the instructor.

DESIRED BEHAVIOR: the trainee will perform workmanship qualification testing.

EVALUATION CRITERIA: The trainee produces sound fillet and groove welds on stainless steel round tubing and sheet, using an argon shielding gas supply, ER3XX (stainless steel) filler metal and EWTh-2 or EWCe-2 tungsten electrodes. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.009 and Drawing #AWS2-5, the trainee shall pass the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification testing [summative testing].

LEARNING ACTIVITIES:

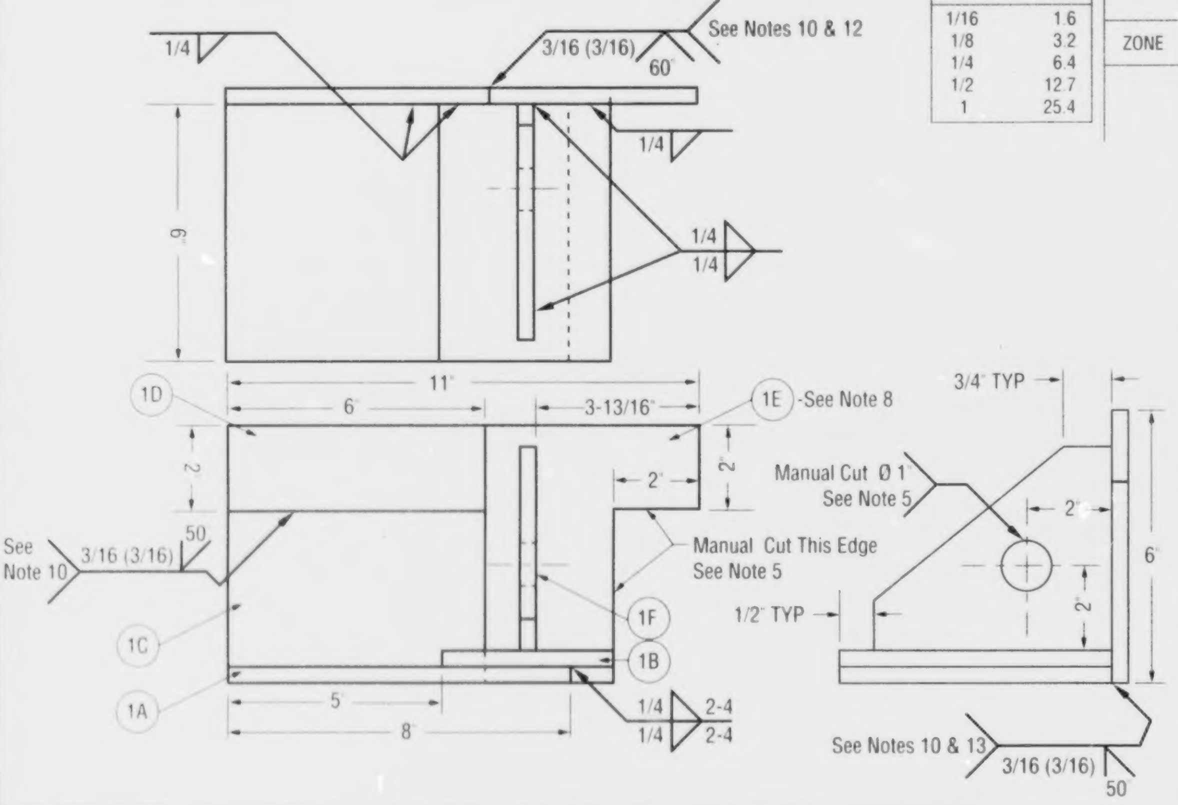
The instructor shall:

1. Provide instruction in welding procedure and workmanship qualification related to this learning objective.
2. Provide instruction in visual examination requirements for workmanship qualification related to this learning objective.
3. Provide demonstrations of fabrication and welding the workmanship qualification test weldment related to this learning activity.
4. Provide training exercises for fabricating and welding the workmanship qualification test weldment related to this learning activity.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Visually inspect trainee's workmanship sample.
9. Prepare trainee for the layout, fitup, weld symbol interpretation and welding elements of workmanship qualification for visual examination.
10. Administer workmanship qualification testing in accordance with the requirements of AWS QC11, WPS ANSI/AWS B2.1.009 and Drawing #AWS2-5.
11. Keep training records reflecting results of workmanship qualification testing for Drawing #AWS2-5.

NOTE: **1. The workmanship qualification test related to drawing #AWS2-5 (refer to figure 6 of this guide) may be delivered at the end of training for GTAW of aluminum round tubing, or at the end of the program.**

2. Workmanship Qualification is mandatory for Level II-Advanced Welder Qualification. However, Workmanship Qualification for Learning Objective #18 may be substituted by Performance Qualification testing using the AWS QC7 option specified in section 4.2.4 *GTAW Performance Qualifications* of this guide. Where performance qualification is substituted for workmanship qualification, the trainee shall not be required to perform the workmanship test for this learning objective.

Figure 2 – Level II – Advanced Welder, SMAW, Stainless Steel, Workmanship Qualification Test.


1/4
3/16 (3/16)
60°
See Notes 10 & 12
1/4
1/4
1/4
6"
11"
6"
3-13/16"
1D
1E
-See Note 8
2"
2"
2"
50
See Note 10
3/16 (3/16)
Manual Cut This Edge
See Note 5
1F
1C
1B
1A
5"
8"
1/4
1/4
2-4
2-4
3/4" TYP
Manual Cut Ø 1"
See Note 5
2"
6"
1/2" TYP
2"
See Notes 10 & 13
3/16 (3/16)
50°

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 1/4" thickness carbon steel material.
   1/4" thickness 3XX stainless steel material (optional).
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All carbon steel parts may be mechanically cut or machine OFC unless indicated "Manual Cut" then use manual OFC.
   All stainless steel parts may be mechanically cut or machine PAC unless indicated "Manual Cut" then use manual PAC.
6. Filler metals as specified by WPS. (See Note 11)
7. Fit and tack entire assembly on bench before attaching to positioning fixture arm.
8. Attach 2" x 2" extension tab of part 1E to positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION
9. Employ boxing technique where applicable.
10. Partial penetration weld.
11. Use WPS AWS2-1-SMAW for carbon steel base metal.
    Use WPS ANSI/AWS B2.1-8-023 for stainless steel base metal.
12. Weld joins Parts 1C and 1D to 1E.
13. Weld joins Parts 1C and 1E to 1A.
14. Visual examination in accordance with the requirements of AWS QC11, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			
1E			
1F			

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions ± 1/16" Angles +10°, -5°

Level II - Advanced Welder — SMAW Stainless Steel — Workmanship Qualification

DR BY:	DATE:	SIZE	QC NO:	DWG NO:	REV:
D. Cantelope	1/5/96		11-96	AWS2-1	

CHK BY:	DATE:	APPROVED:	DATE:	SHEET:
R. V. Reeve	1/6/96	AWS-EGC2	2/18/96	1 of 1

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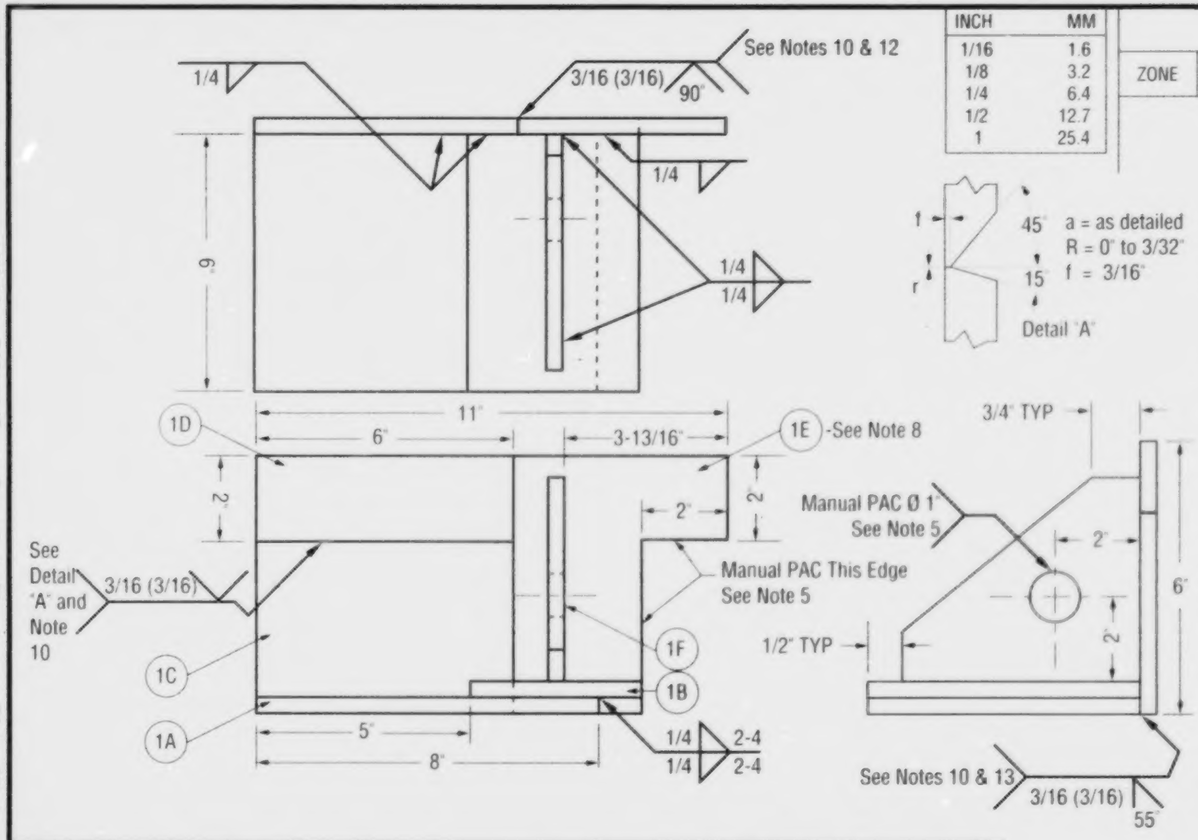

1/4
3/16 (3/16)
90°
See Notes 10 & 12
1/4
1/4
1/4
6"
11"
6"
3-13/16"
1D
1E
-See Note 8
2"
2"
2"
See Detail "A" and Note 10
3/16 (3/16)
Manual PAC This Edge
See Note 5
1C
1F
1B
1A
5"
8"
1/4
1/4
2-4
2-4
f
r
45°
15°
a = as detailed
R = 0" to 3/32"
f = 3/16"
Detail "A"
3/4" TYP
Manual PAC Ø 1"
See Note 5
2"
6"
2"
1/2" TYP
See Notes 10 & 13
3/16 (3/16)
55°

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 3/8" thickness aluminum (M-23/P-23/S-23 to M-23/P-23/S-23) or (M-22/P-22/S-22 to M-22/P-22/S-22), as detailed in AWS B2.1.
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine PAC unless indicated manual PAC.
6. All welds GMAW, spray transfer.
7. Fit and tack entire assembly on bench before attaching to positioning fixture arm.
8. Attach 2" x 2" extension tab of part 1E to positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Partial penetration weld.
11. Use WPS AWS2-1-GMAW for (M-23/P-23/S-23). Use WPS AWS2-1.1-GMAW for (M-22/P-22/S-22).
12. Weld joins Parts 1C and 1D to 1E.
13. Weld joins Parts 1C and 1E to 1A.
14. Visual examination in accordance with the requirements of AWS QC11, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			
1E			
1F			

American Welding Society

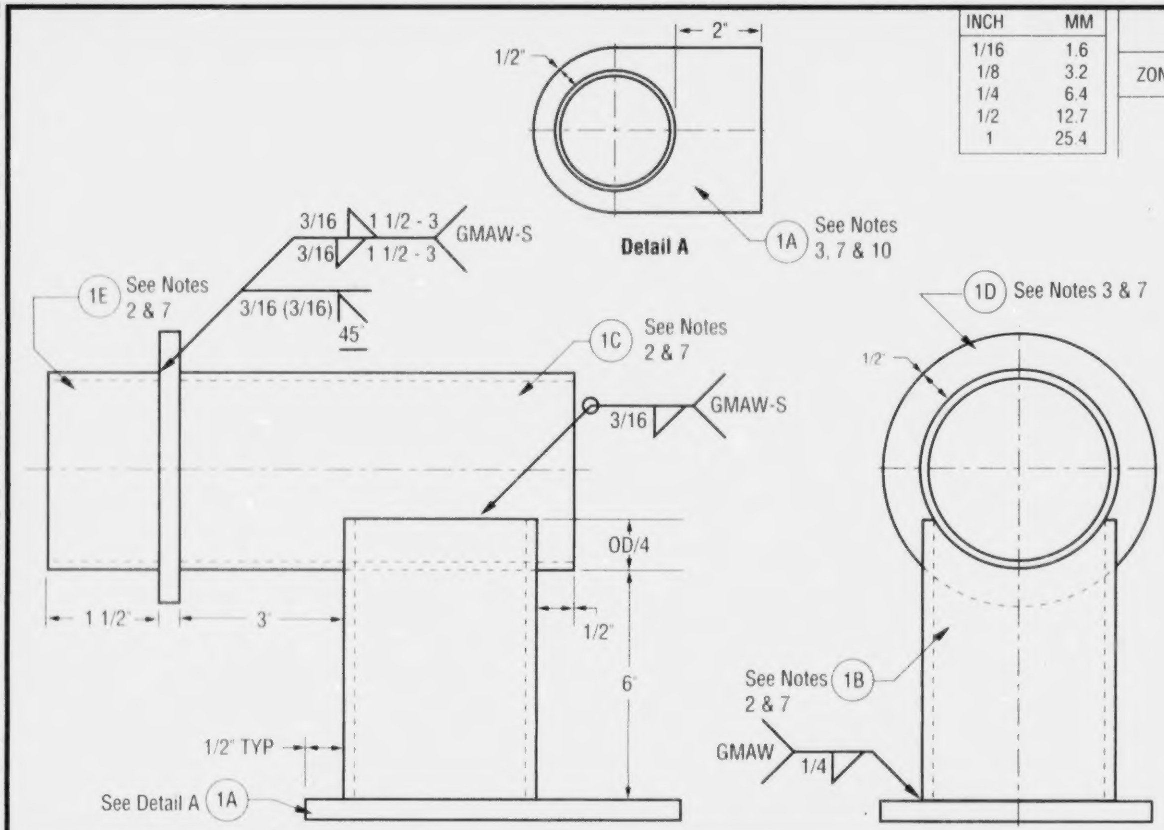
TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions: ± 1/16" Angles: +10°, -5°

Level II - Advanced Welder — GMAW Aluminum — Workmanship Qualification

DR BY: D. Cantelope	DATE: 1/5/96	SIZE	QC NO: 11-96	DWG NO: AWS2-2	REV:
CHK BY: R.V. Reeve	DATE: 1/6/96	APPROVED: AWS-EGC2	DATE: 2/18/96	SHEET: 1 of 1	

Figure 3 – Level II – Advanced Welder, GMAW (Spray Transfer), Aluminum – Plate, Workmanship Qualification Test.

Figure 4 – Level II – Advanced Welder, GMAW–S,GMAW (Spray Transfer), Carbon Steel –Pipe & Plate, Workmanship Qualification Test.



INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 4" - 6" Ø Schedule 40 carbon steel pipe. Optional choice of pipe diameter within range specified.
3. 1/4" thickness carbon steel plate. Useable pieces may be joined to obtain design size Parts 1A & 1D. If joined all additional welds shall be ground flush prior to assembly of AWS2-3 weldment.
4. Use .035 diameter E70S-X electrode.
5. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
6. The welder shall convert the above bill of materials to S.I. metric units of measure.
7. Parts 1A,1B & 1D manual OFC. Saddle Part 1B to accommodate Part 1C. Parts 1C & 1E may be mechanically, machine OFC, or manual OFC cut.
8. All welds GMAW-S or GMAW (spray) as specified.
9. Fit and tack entire assembly on bench before welding.
10. Attach Part 1A to welding table or positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
11. Melt through not required.
12. Use WPS AWS2-2-GMAW for short circuiting transfer. Use WPS AWS2-3-GMAW for spray transfer.
13. Visual examination in accordance with the requirements of AWS QC11, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			
1E			

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions: ± 1/16" Angles: + 10 , -5

Level II - Advanced Welder — GMAW-S, GMAW (spray) — Workmanship Qualification

DR BY: D. Cantelope DATE: 1/5/96
SIZE: QC NO: 11-96 DWG NO: AWS2-3 REV:
CHK BY: R.V. Reeve DATE: 1/6/96
APPROVED: AWS-EGC DATE: 1/31/96 SHEET: 1 of 1

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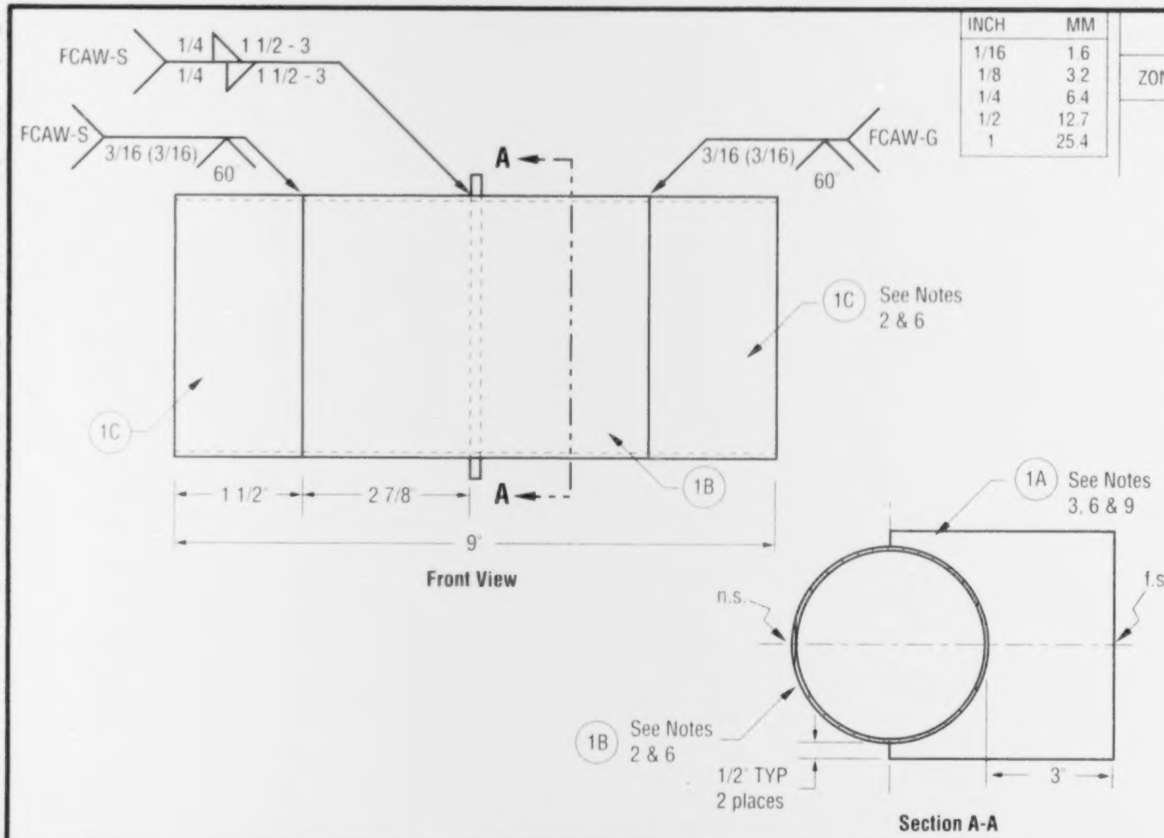

Figure 5 – Level II – Advanced Welder, FCAW, FCAW-G, Carbon Steel – Pipe & Plate, Workmanship Qualification Test.

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 4" - 6" Ø Schedule 40 carbon steel pipe. Optional choice of pipe diameter within range specified.
3. 1/4" thickness carbon steel plate. Useable pieces may be joined to obtain design size Part 1A. If joined all additional welds shall be ground flush prior to assembly of AWS2-4 weldment.
4. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
5. The welder shall convert the above bill of materials to S.I. metric units of measure.
6. Part 1A manual OFC. Parts 1B & 1C may be mechanically, machine OFC, or manual OFC cut.
7. All welds FCAW-S or FCAW-G as specified.
8. Fit and tack entire assembly on bench before welding.
9. Attach far side of part 1A to positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
10. Melt through not required.
11. Use WPS ANSI/AWS B2.1.020 or ANSI/AWS B2.1.019 for gas-shielded.
    Use WPS ANSI/AWS B2.1-1-027 for self-shielded.
12. Visual examination in accordance with the requirements of AWS QC11, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			

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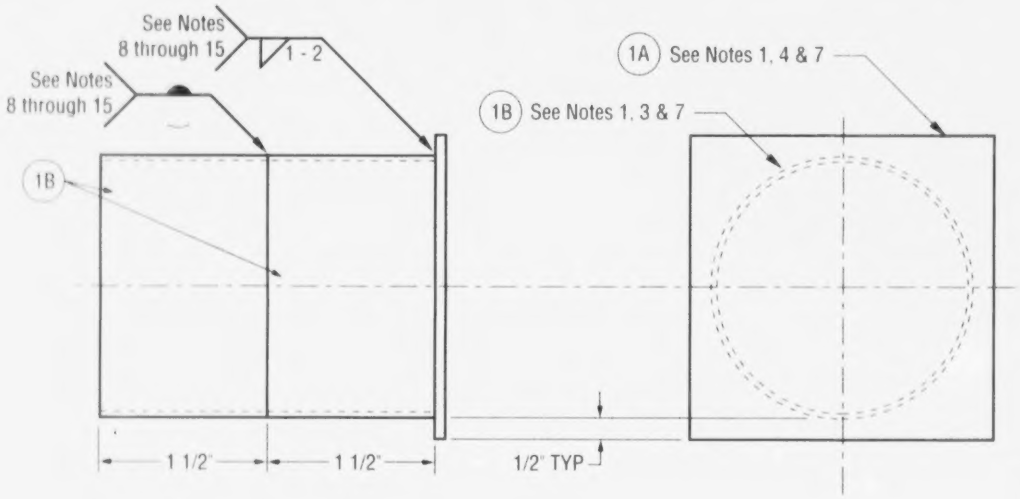
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10° -5°		Level II - Advanced Welder — FCAW-S, FCAW-G — Workmanship Qualification		
DR BY: D. Cantelope	DATE: 1/5/96	SIZE	QC NO: 11-96	DWG NO: AWS2-4 REV:
CHK BY: R.V. Reeve	DATE: 1/6/96	APPROVED: AWS-EGC	DATE: 1/31/96	SHEET: 1 of 1

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



NOTES
1. 1 each required, carbon steel, aluminum and stainless steel.
2. All dimensions U.S. customary unless otherwise specified.
3. 3" Ø, 10 ga. - 18 ga. thickness round tubing. Optional choice of wall thickness within range specified.
4. 10 ga. - 18 ga. material thickness for sheet. Optional choice of thickness within range specified.
5. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
6. The welder shall convert the above bill of materials to S.I. metric units of measure.
7. Part 1A manual PAC. Part 1B may be mechanically or manual PAC cut. Uniformly radius all sharp corners.
8. All Welds GTAW. Fillet weld size = 1 1/2 times the nominal wall thickness of the round tubing. Groove weld root opening = 1/2 the nominal wall thickness of the round tubing.
9. Groove weld joint geometry 16-18 gage use square groove. Groove weld joint geometry 10-14 gage use v-groove.
10. No melt through on fillet welds.
11. Root shielding gas required for aluminum and stainless steel.
12. Fit and tack entire assembly on bench before welding.
13. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
14. Use WPS ANSI/AWS B2.1.008 for carbon steel
    Use WPS AWS2-1-GTAW for aluminum (M-23/P-23/S-23).
    Use WPS AWS2-1.1-GTAW for aluminum (M-22/P-22/S-22).
    Use WPS ANSI/AWS B2.1.009 for stainless steel.
15. Visual examination in accordance with the requirements of AWS QC11, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			

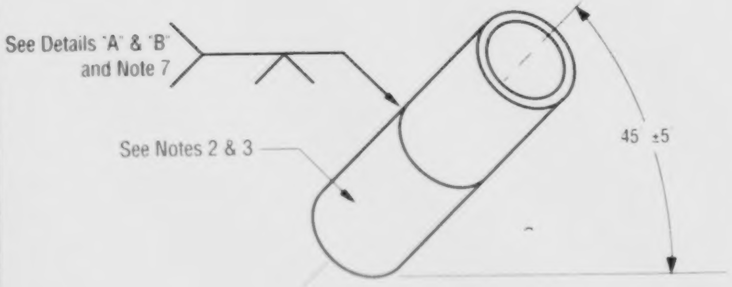
American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions: ± 1/16" Angles: + 10', -5'

Level II - Advanced Welder — GTAW — Workmanship Qualification

DR BY: D. Cantelope DATE: 1/5/96
CHK BY: R.V. Reeve DATE: 1/6/96
SIZE: QC NO: 11-96 DWG NO: AWS2-5 REV:
APPROVED: AWS-EGC DATE: 1/31/96 SHEET: 1 of 1

Figure 6 – Level II – Advanced Welder, GTAW, Carbon Steel, Stainless Steel, Aluminum – Round Tubing & Sheet, Workmanship Qualification Tests.



PIPE INCLINATION FIXED (45 ±5) AND NOT ROTATED DURING WELDING

TEST POSITION 6G

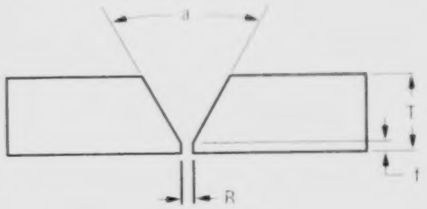
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

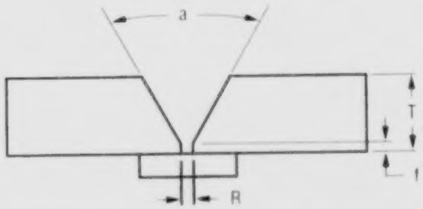
Notes:

1. Duplicate performance qualification tests are not required if welder is tested under AWS QC11 using the AWS QC7 option.
2. 6" or 8" Ø Schedule 80 carbon steel pipe. Pipe diameter optional within range specified.
3. The standard pipe groove test weldment for performance qualification shall consist of two pipe sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. With or without backing. Refer to Details "A" and "B". Backing ring to suit diameter and nominal wall thickness of pipe.
5. All welding done in position according to applicable performance qualification requirement.
6. All parts may be mechanically cut or machine OFC.
7. Use WPS ANSI/AWS B2.1-1-022 for performance qualification without backing. Use WPS ANSI/AWS B2.1-1-016 for performance qualification with backing.
8. Visual examination in accordance with the requirements of QC11, Table 1. Bend test in accordance with the requirements of QC11, Table 2 and Annex D, Figures 7 and 8.



a = 60° minimum
R = 1/8", +1/16" -1/16"
t = 1/16 maximum

DETAIL "A" - Joint Geometry Without Backing



a = 60° minimum
R = 3/16", +1/4" -1/16"
t = R/2 maximum

DETAIL "B" - Joint Geometry With Backing

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions ± 1/16" Angles + 10 -5

Level II - Advanced Welder — SMAW — Carbon Steel 6G — Performance Qualification

DR BY D. Cantelope	DATE 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-6	REV
CHK BY R.V. Reeve	DATE 1/6/96	APPROVED AWS-EGC	DATE 1/31/96	SHEET 1 of 1	

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Figure 7 – Level II – Advanced Welder, SMAW, Carbon Steel – Pipe, Performance Qualification Test. This Performance Qualification Test may be administered under the AWS QC7 option of AWS QC11.

4. Optional Welder Qualification — AWS QC7 — AWS Certified Welders

4.1 General Guidelines.

4.1.1 Scope. This section establishes guidelines for QC 11 Participating Organizations to qualify and certify Level II – Advanced Welder performance qualification tests at an AWS QC4, *Accredited Test Facility* using the AWS QC7, *Standard for AWS Certified Welders*. All welder performance qualifications listing herein are done so using AWS QC7 Supplement G, *AWS Performance Qualification Test*, and AWS B2.1, *Standard for Welding Procedure and Performance Qualification*. The purpose of AWS QC7 is to document the ability of welders to deposit sound welds (qualify) and to impose controls on the documentation and maintenance of certification (certify). The AWS QC7 standard contains criteria for the *AWS Certified Welder Program* and the *AWS National Registry of Welders*. In many cases welder qualification under the QC7 program allows transfer of welder qualification from employer to employer. This potential transfer of welder qualification may affect financial savings to the welding industry. AWS Accredited Test Facilities operate under the requirements of AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program*.

4.1.2 Program. Optional Level II – Advanced Welder performance qualification shall conform to AWS QC11, *Level II – Advanced Welder Program* requirements for welder performance qualification testing administered at an AWS QC4, *Accredited Test Facility* through the AWS QC7, *Certified Welder Program*.

4.1.3 Testing Facility. Optional Level II – Advanced Welder performance qualifications, for the AWS QC11, *Level II – Advanced Welder Program*, shall be conducted by an AWS Accredited Test Facility and conform to the rules of AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program*. Arrangements for site testing at the Participating Organization's training facility may be conducted provided the Accredited Test Facility is approved for remote location testing.

4.1.4 Certification Requisites. Individuals desiring optional QC7 welder certification shall provide documentation showing successful completion of a closed book written examination in accordance with the requirements of AWS QC 11 and section 1.3 of this guide, prior to the administration of performance qualification testing. Applicants applying for optional QC7 certification shall meet the requisites specified in AWS QC7, *Standard for AWS Certified Welders*, 5. Certification Requisites.

4.1.5 Testing. Participating Organizations may elect to substitute any of the performance qualifications listed in **4.2** *Performance Qualifications*, for the workmanship or performance qualification tests required by AWS QC 11 and detailed in **3.** *Curriculum Guidelines* of this guide. Substituted performance qualifications shall cover all aspects of the replaced workmanship or performance qualification test, with respect to welding process, welding positions, base metal, filler metal and product form.

4.1.6 Retests. If an optional Level II – Advanced Welder performance qualification test fails to meet the requirements for visual examination and bend testing, a retest may be allowed as specified in AWS QC7, *Supplement G*, section G7.

4.1.5 Other Codes or Standards. Participating Organizations desiring welder performance qualification testing using the AWS QC7 option of AWS QC11 may substitute the performance qualifications listed in **4.2** *Performance Qualifications*, with any recognized code or standard and qualified welding procedures independently developed by an employer provided the following conditions are met:

1) The performance qualification test specified by the other code, standard or employer's welding procedure satisfies or exceeds the workmanship and performance qualification requirements of AWS QC11, *Specification for Qualification and Certification for Level II – Advanced Welders*.

2) Performance qualification tests are administered using AWS QC7, Supplement G at an AWS Accredited Test Facility.

3) The performance qualification test is within the limits of AWS QC11, Level II – Advanced Welder certification and meets or exceeds conditions for welding process, position, base metal, filler metal and product form.

4) A procedure qualification test is conducted and the results recorded on a Procedure Qualification Record (PQR) for joints that are not prequalified

5) The Participating Organization submits a Welding Procedure Specification documenting the essential welding variables for the other code, standard or employer's welding procedures at the time the performance qualification test is administered by the AWS Accredited Test Facility.

6) The other code, standard or employer's welding procedure meets or exceeds the requirements for visual examination and bend testing of AWS B2.1, *Standard for Welding Procedure and Performance Qualification*.

4.2 Performance Qualifications.

4.2.1 Shielded Metal Arc Welding (SMAW) Performance Qualifications

4.2.1.1 SMAW Stainless Steel Plate. Optional performance qualification testing for stainless steel plate shall be conducted using WPS ANSI/AWS B2.1-8-023 and Drawing #AWS2-4-1 (see Figure 8). These performance qualification tests supersede the workmanship qualification test for Course F, Unit #1, Learning Objective #9 and Drawing #AWS2-1 of this guide.

4.2.1.2 SMAW Carbon Steel Pipe. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS ANSI/AWS B2.1-1-022 (with backing) or ANSI/AWS B2.1-1-016 (without backing) and Drawing #AWS2-4-2 (see Figure 9). This performance qualification test supersedes the performance qualification test for Course F, Unit #1, Learning Objective #11 and Drawing #AWS2-6 of this guide.

4.2.2 Gas Metal Arc Welding (GMAW–S, GMAW) Performance Qualifications

4.2.2.1 GMAW Aluminum Plate. Optional performance qualification testing for aluminum plate shall be conducted using WPS AWS2–1–GMAW (for M-23/P-23/S-23) or WPS AWS2–1.1–GMAW (for M-22/P-22/S-22) and Drawing #AWS2–4–3 (see Figure 10). These performance qualification tests supersede the workmanship qualification test for Course F, Unit #2, Learning Objective #8 and Drawing #AWS2–2 of this guide.

4.2.2.2 GMAW–S Carbon Steel Pipe. Optional performance qualification testing for carbon steel pipe and plate snall be conducted using WPS AWS2–2–GMAW and Drawing #AWS2–4–4 (see Figure 11). These performance qualification tests supersede the short circuit transfer portion of the workmanship qualification test for Course F, Unit #2, Learning Objective #12 and Drawing #AWS2–3 of this guide.

4.2.2.3 GMAW Carbon Steel Plate. Optional performance qualification testing for carbon steel pipe and plate shall be conducted using WPS AWS2–3–GMAW and, Drawing #AWS2–4–5 (see Figure 12). This performance qualification test supersedes the spray transfer portion of the workmanship qualification test for Course F, Unit #2, Learning Objective #12 and Drawing #AWS2–3 of this guide.

Note: Performance qualification tests for GMAW–S (short circuiting transfer) and GMAW (spray transfer) must be taken to supersede the requirements of workmanship qualification. Where only one set of tests for either GMAW–S or GMAW are selected, the remaining portion of the workmanship qualification must also be administered prior to performance qualification testing.

4.2.3 Flux Cored Arc Welding (FCAW–S, FCAW–G) Performance Qualifications

4.2.3.1 FCAW–S Carbon Steel Pipe. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS ANSI/AWS B2.1–1–027 and Drawing #AWS2–4–6 (see Figure 13). These performance qualification tests supersede the self-shielded portion of the workmanship qualification test for Course F, Unit #3, Learning Objective #10 and Drawing #AWS2–4 of this guide.

4.2.3.2 FCAW–G Carbon Steel Pipe. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS ANSI/AWS B2.1–1–019 or ANSI/AWS B2.1–1–020 and Drawing #AWS2–4–7 (see Figure 14). These performance qualification tests supersede the gas-shielded portion of the workmanship qualification test for Course F, Unit #3, Learning Objective #10 and Drawing #AWS2–4 of this guide.

Note: Performance qualification tests for FCAW–S and FCAW–G must be taken to supersede the requirements of workmanship qualification. Where only one set of tests for either FCAW–S or FCAW–G are selected, the remaining portion of the workmanship qualification must also be administered prior to performance qualification testing.

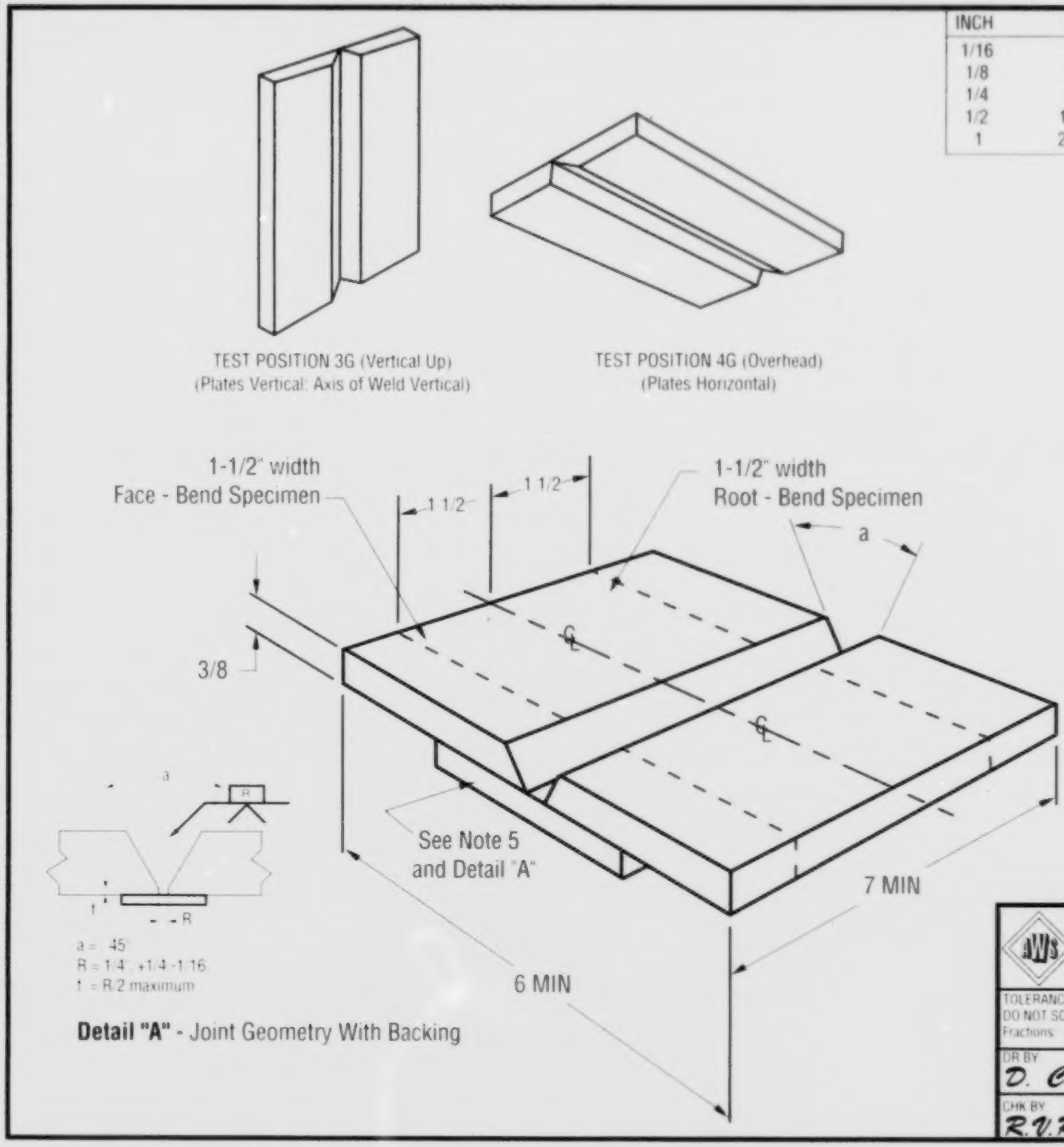
4.2.4 Gas Tungsten Arc Welding (GTAW) Performance Qualifications

4.2.4.1 GTAW Carbon Steel Round Tubing. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS ANSI/AWS B2.1.008 and Drawing #AWS2–4–8 (see Figure 15). These performance qualification tests supersede the carbon steel round tubing portion of the workmanship qualification test for Course F, Unit #4, Learning Objective #16 and Drawing #AWS2–5 of this guide.

4.2.4.2 GTAW Aluminum Round Tubing. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS AWS2-1-GTAW or WPS AWS2-1.1-GTAW and Drawing #AWS2–4–9 (see Figure 16). These performance qualification tests supersede the gas-shielded portion of the workmanship qualification test for Course F, Unit #4, Learning Objective #17 and Drawing #AWS2–5 of this guide.

4.2.4.2 GTAW Stainless Round Tubing. Optional performance qualification testing for carbon steel pipe shall be conducted using WPS ANSI/AWS B2.1.009 and Drawing #AWS2–4–10 (see Figure 17). These performance qualification tests supersede the gas-shielded portion of the workmanship qualification test for Course F, Unit #4, Learning Objective #18 and Drawing #AWS2–5 of this guide.

Figure 8 – Level II – Advanced Welder, QC7 Optional Performance Qualification, SMAW Stainless Steel Plate.


TEST POSITION 3G (Vertical Up)
(Plates Vertical; Axis of Weld Vertical)
TEST POSITION 4G (Overhead)
(Plates Horizontal)
1-1/2" width
Face - Bend Specimen
1 1/2
1 1/2
1-1/2" width
Root - Bend Specimen
a
3/8
℄
℄
See Note 5
and Detail "A"
7 MIN
6 MIN
a
R
t
R
a = 45°
R = 1/4", +1/4 -1/16
t = R/2 maximum

Detail "A" - Joint Geometry With Backing

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for SMAW of stainless steel.
2. 3/8" thickness austenitic stainless steel (M-8/P-8/S-8, Group 1), as detailed in AWS B2.1 and WPS ANSI/AWS B2.1-8-023.
3. Performance Qualification #1 = 3G position.
   Performance Qualification #2 = 4G position.
4. All welding done in position according to applicable performance qualification requirement.
5. With backing. Backing material 1/4" x 3" x 7" minimum (M8/P-8/S-8, Group 1) as specified in AWS B2.1.
6. All parts may be mechanically cut or machine PAC.
7. Use WPS ANSI/AWS B2.1-8-023
8. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.2.1 and Figure 3.7.2A.

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions: ± 1/16 Angles + 10 -5	Level II - Advanced Welder—SMAW— 3G, 4G — QC7 Optional Performance Qualification			
DR BY D. Cantelope DATE 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-4-1	REV
CHK BY R.V. Reeve DATE 1/6/96	APPROVED AWS-EGC DATE 1/31/96		SHEET 1 of 1	

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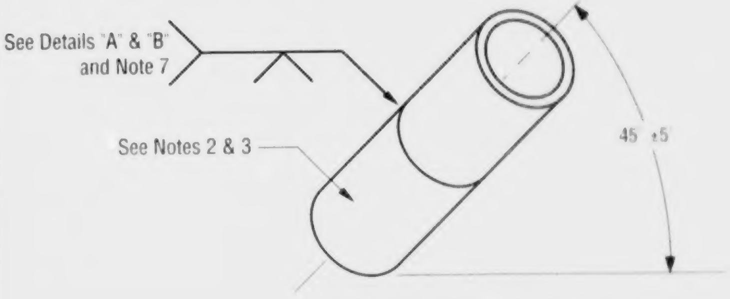
Figure 9 – Level II – Advanced Welder, QC7 Optional Performance Qualification, SMAW Carbon Steel Pipe.

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

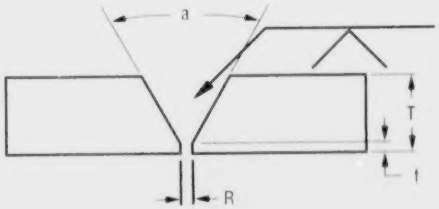
REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



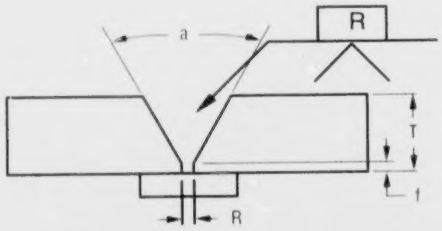
PIPE INCLINATION FIXED (45 ±5) AND NOT ROTATED DURING WELDING

TEST POSITION 6G



a = 60° minimum
R = 5/32", ±1/16"
f = 1/16 minimum

DETAIL "A" - Joint Geometry Without Backing



a = 60° minimum
R = 3/16", +1/4" -1/6
f = R/2 maximum

DETAIL "B" - Joint Geometry With Backing

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Performance Qualification for SMAW of carbon steel pipe.
2. 6" or 8" Ø Schedule 80 carbon steel pipe (M-1/P-1/S-1, Group 1 or 2).
3. The standard pipe groove test weldment for performance qualification shall consist of two pipe sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. With or without backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Details "A" and "B".
5. All welding done in position according to applicable performance qualification requirements.
6. All parts may be mechanically cut or machine OFC.
7. Use WPS ANSI/AWS B2.1-1-022 for performance qualification without backing.
   Use WPS ANSI/AWS B2.1-1-016 for performance qualification with backing.
8. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1B.

American Welding Society

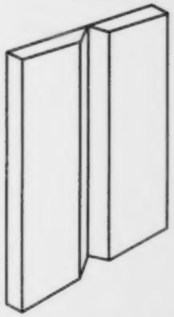
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10 , -5		Level II - Advanced Welder — SMAW — 6G — QC7 Optional Performance Qualification			
DR BY D. Cantelope	DATE 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-4-2	REV
CHK BY R.V. Reeve	DATE 1/6/96	APPROVED AWS-EGC	DATE 1/31/96	SHEET 1 of 1	

BEST COPY AVAILABLE

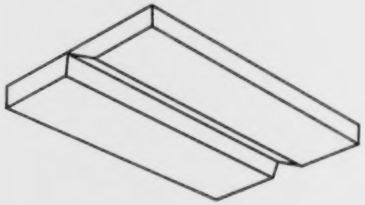
Figure 10 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GMAW, Aluminum Plate.

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

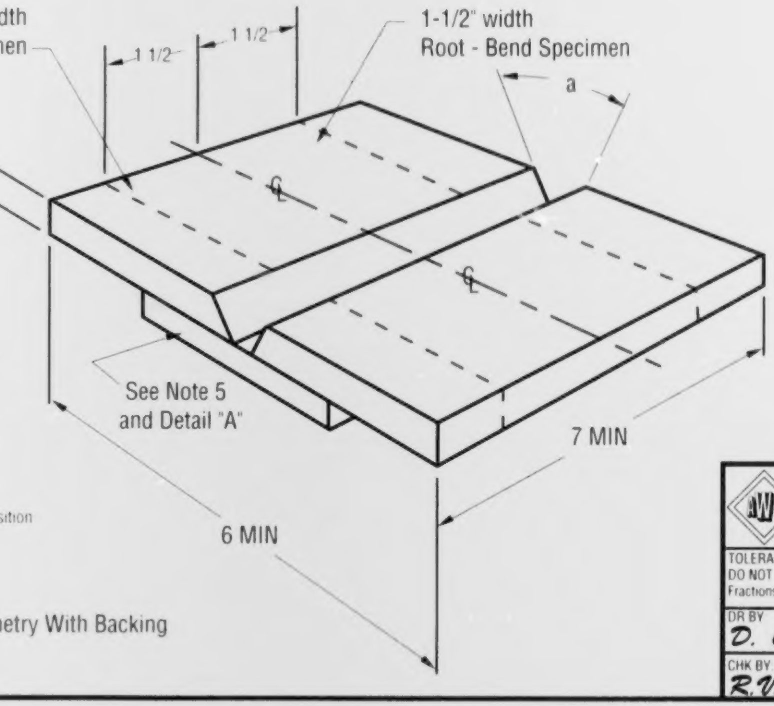
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

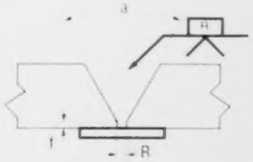


TEST POSITION 3G (Vertical Up)
(Plates Vertical; Axis of Weld Vertical)



TEST POSITION 4G (Overhead)
(Plates Horizontal)





a = 60° flat position
90° horizontal or vertical position
110° overhead position
R = 3/32, +1/8 -1/16
t = 1/16 minimum

Detail "A" - Joint Geometry With Backing

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GMAW (spray transfer) of aluminum.
2. 3/8" thickness aluminum (M-23/P-23/S-23 or (M-22/P-22/S-22 to M-22/P-22/S-22), as detailed in AWS B2.1.
3. Performance Qualification #1 = 3G position.
   Performance Qualification #2 = 4G position.
4. All welding done in position according to applicable performance qualification requirement.
5. With backing. Backing material 1/4" x 3" x 7" minimum (M-23/P-23/S-23 to M-23/P-23/S-23) or (M-22/P-22/S-22 to M-22/P-22/S-22), as specified in AWS B2.1.
6. All parts may be mechanically cut or machine PAC.
7. Use WPS AWS2-1-GMAW for (M-23/P-23/S-23).
   Use WPS AWS2-1.1-GMAW for (M-22/P-22/S-22).
8. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.2.1 and Figure 3.7.2A.

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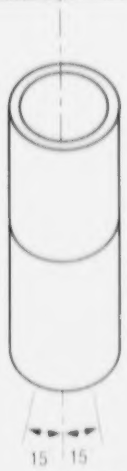
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10, -5		Level II - Advanced Welder—GMAW— 3G, 4G — QC7 Optional Performance Qualification			
DR BY D. Cantelope	DATE 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-4-3	REV
CHK BY R.V. Reeve	DATE 1/6/96	APPROVED DATE AWS-EGC 1/31/96		SHEET 1 of 1	

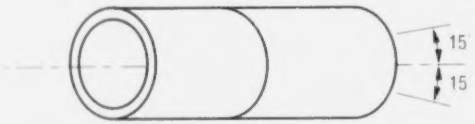
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



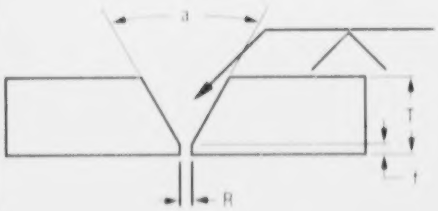
PIPE OR TUBE VERTICAL AND NOT ROTATED DURING WELDING WELD HORIZONTAL (+15°)

TEST POSITION 2G (HORIZONTAL)



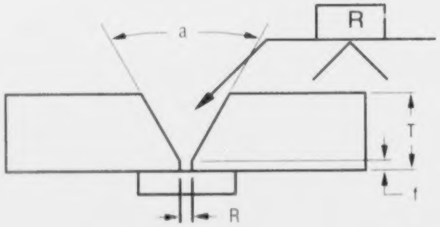
PIPE HORIZONTAL FIXED (±15°) AND NOT ROTATED DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

TEST POSITION 5G (MULTIPLE)



a = 60°, +10° -5°
R = 5/32", ±1/16"
f = 1/16 minimum

DETAIL "A" - Joint Geometry Without Backing



a = 60°, +10° -5°
R = 5/32", ±1/16"
f = 1/16 minimum

DETAIL "B" - Joint Geometry With Backing

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GMAW (short circuit transfer) of carbon steel pipe.
2. 4" or 6" Ø Schedule 40 carbon steel pipe (M-1/P-1/S-1, Group 1 or 2).
3. The standard pipe groove test weldments for performance qualification shall consist of two pipe sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With or without backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Details "A". and "B".
7. All parts may be mechanically cut or machine OFC.
8. Use WPS AWS2-2-GMAW.
9. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C.

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions ± 1/16" Angles + 10°, -5°

Level II - Advanced Welder—GMAW-S— 2G, 5G — QC7 Optional Performance Qualification

DR BY D. Cantelope	DATE 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-4-4	REV
CHK BY R.V. Reeve	DATE 1/6/96	APPROVED AWS-EGC	DATE 1/31/96	SHEET 1 of 1	

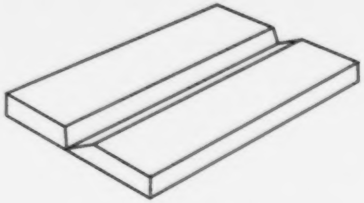
Figure 11 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GMAW–S Carbon Steel Pipe.

Figure 12 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GMAW Carbon Steel Plate.

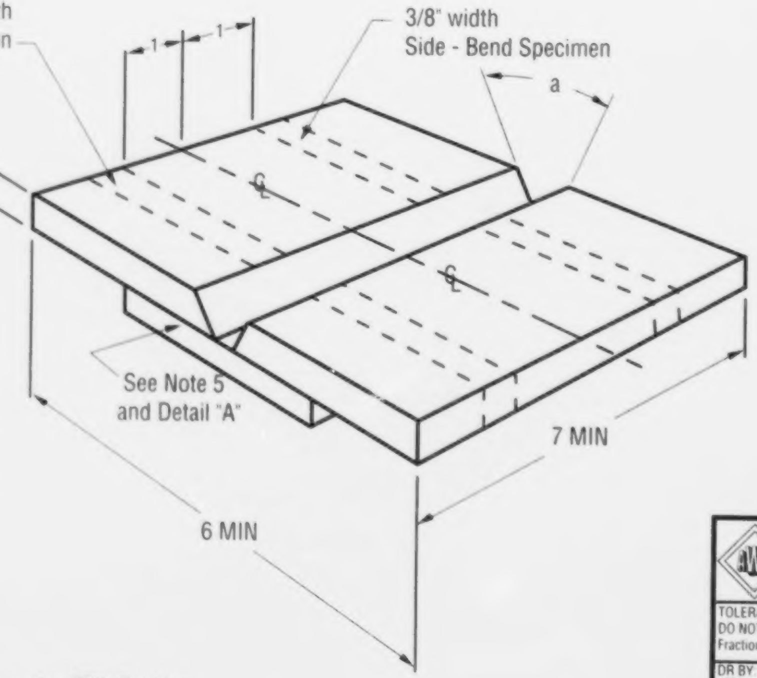
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

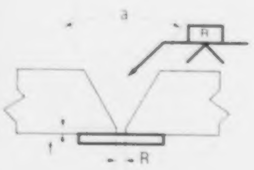
REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



TEST POSITION 1G (flat)
(Plates Horizontal)





a = 45° minimum
R = 1/4" +1/4" -1/16"
f = R/2 maximum

Detail "A" - Joint Geometry With Backing

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GMAW (spray transfer) of carbon steel pipe.
2. 1" thickness carbon steel (M-1/P-1/S-1, group 1 or 2), as detailed in AWS B2.1.
3. Performance Qualification #1 = 1G position.
4. All welding done in position according to applicable performance qualification requirement.
5. With backing. Backing material 1/4" x 3" x 7" minimum (M-1/P-1/S-1, Group 1 or 2) as specified in AWS B2.1.
6. All parts may be mechanically cut or machine OFC.
7. Use WPS AWS2-3-GMAW.
8. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test as detailed and in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.2.1 and Figure 3.7.2A.

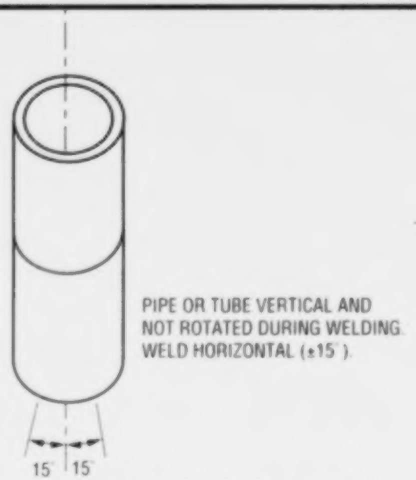
American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions: ± 1/16" Angles: + 10°, -5°	Level II - Advanced Welder — GMAW — 1G — QC7 Optional Performance Qualification			
DR BY: D. Cantelope DATE: 1/5/96	SIZE	QC NO 11-96	DWG NO AWS2-4-5	REV
CHK BY: R.V. Reeve DATE: 1/6/96	APPROVED AWS-EGC DATE: 1/31/96		SHEET 1 of 1	

Figure 13 – Level II – Advanced Welder, QC7 Optional Performance Qualification, FCAW–S Carbon Steel Pipe.

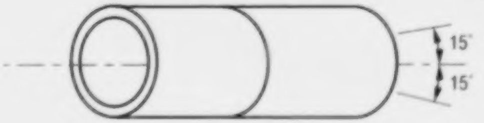
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



PIPE OR TUBE VERTICAL AND
NOT ROTATED DURING WELDING.
WELD HORIZONTAL (±15°).

TEST POSITION 2G (HORIZONTAL)

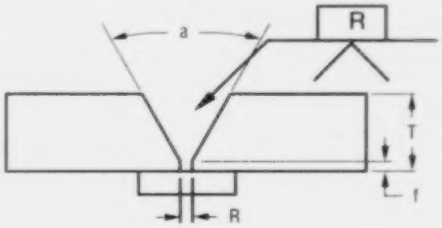


PIPE HORIZONTAL FIXED (±15°) AND NOT ROTATED
DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD

TEST POSITION 5G (MULTIPLE)

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for FCAW-S (self-shielded) of carbon steel pipe.
2. 6" or 8" Ø Schedule 80 carbon steel pipe (M-1/P-1/S-1, Group 1 or 2).
3. The standard pipe groove test weldments for performance qualification shall consist of two pipe sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Detail "A".
7. All parts may be mechanically cut or machine OFC.
8. Use WPS ANSI/AWS B2.1-1-027.
9. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C.



a = 60° minimum
R = 3/16", +1/4" -1/16"
f = R/2 maximum

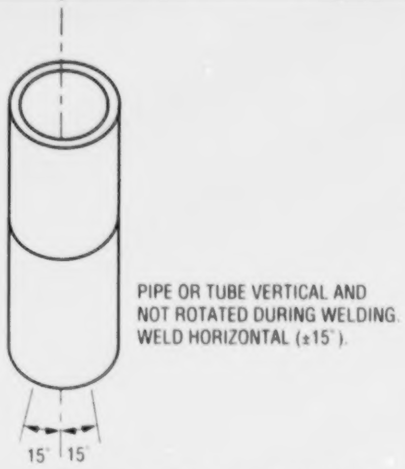
(A) Joint Detail - with backing

American Welding Society

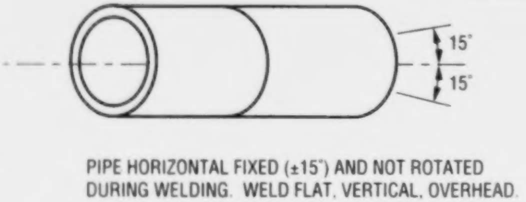
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions: ± 1/16" Angles: + 10°, -5°		Level II - Advanced Welder—FCAW-S— 2G, 5G — QC7 Optional Performance Qualification			
DR BY: D. Cantelope	DATE: 1/5/96	SIZE:	QC NO: 11-96	DWG NO: AWS2-4-6	REV:
CHK BY: R.V. Reeve	DATE: 1/6/96	APPROVED: AWS-EGC	DATE: 1/31/96	SHEET: 1 of 1	

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

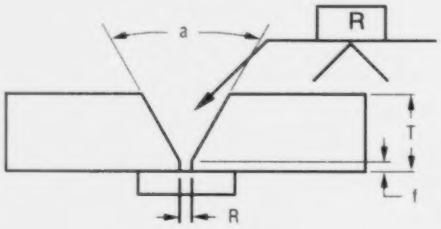
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED


PIPE OR TUBE VERTICAL AND NOT ROTATED DURING WELDING. WELD HORIZONTAL (±15°).
15°
15°

TEST POSITION 2G (HORIZONTAL)


15°
15°
PIPE HORIZONTAL FIXED (±15°) AND NOT ROTATED DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

TEST POSITION 5G (MULTIPLE)



a = 60° minimum
R = 3/16", +1/4" -1/16"
f = R/2 maximum

(A) Joint Detail - with backing

Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for FCAW-S (gas-shielded) of carbon steel pipe.
2. 6" or 8" Ø Schedule 80 carbon steel pipe (M-1/P-1/S-1, Group 1 or 2).
3. The standard pipe groove test weldments for performance qualification shall consist of two pipe sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Detail "A".
7. All parts may be mechanically cut or machine OFC.
8. Use WPS ANSI/AWS B2.1-1-019 or ANSI/AWS B2.1-1-020.
9. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
   Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C.

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions: ± 1/16" Angles: + 10°, -5°		Level II - Advanced Welder—FCAW-G — 2G, 5G — QC7 Optional Performance Qualification			
DR BY: D. Cantelope	DATE: 1/5/96	SIZE	QC NO: 11-96	DWG NO: AWS2-4-7	REV:
CHK BY: R.V. Reeve	DATE: 1/6/96	APPROVED: AWS-EGC	DATE: 1/31/96	SHEET: 1 of 1	

Figure 14 – Level II – Advanced Welder, QC7 Optional Performance Qualification, FCAW–G Carbon Steel Pipe.

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Figure 15 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GTAW Carbon Steel Round Tubing.

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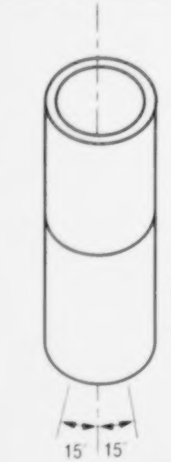
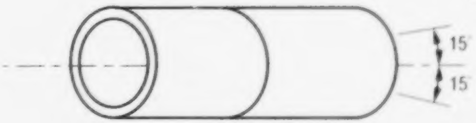


ROUND TUBING VERTICAL AND
NOT ROTATED DURING WELDING.
WELD HORIZONTAL (±15°).

TEST POSITION 2G (HORIZONTAL)



ROUND TUBING HORIZONTAL FIXED (±15°) AND NOT ROTATED
DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

TEST POSITION 5G (MULTIPLE)

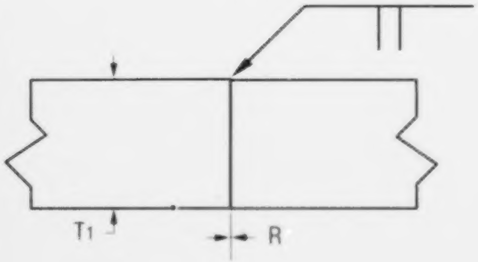
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

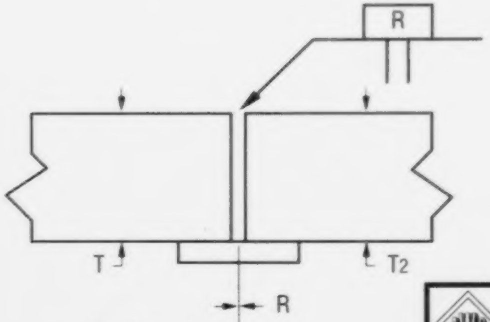
Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GTAW of carbon steel round tubing.
2. 1" – 2-7/8" Ø, 10 ga. - 18 ga. carbon steel round tubing. Optional choice of diameter and wall thickness within range specified.
3. The standard round tubing groove test weldments for performance qualification shall consist of two round tubing sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With or without backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Details "A" and "B".
7. Root shielding gas optional.
8. All parts may be mechanically cut or machine OFC.
9. Use WPS ANSI/AWS B2.1.008.
10. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1. Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C. Bend specimens = 1/2" (13 mm) wide x 6 in (150 mm) long.



R = T_1 (maximum)
T = 10 ga. through 18 ga.

(A) Joint Detail - without backing



R = T_1 (maximum)
$T_1 = T_2$
T = 10 ga. through 18 ga.

(B) Joint Detail - with backing

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions: ± 1/16" Angles: + 10°, -5°	Level II - Advanced Welder—GTAW — 2G, 5G — QC7 Optional Performance Qualification			
DR BY D. Cantelope DATE 1/5/96	SIZE	QC NO. 11-96	DWG NO. AWS2-4-8	REV
CHK BY R.V. Reeve DATE 1/6/96	APPROVED AWS-EGC DATE 1/31/96		SHEET 1 of 1	

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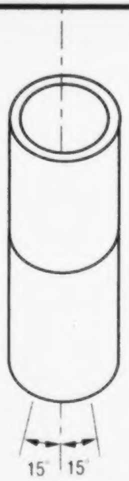
Figure 16 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GTAW Aluminum Round Tubing.

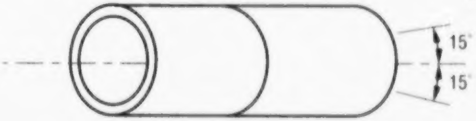
INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



ROUND TUBING VERTICAL AND NOT ROTATED DURING WELDING. WELD HORIZONTAL (±15°).

TEST POSITION 2G (HORIZONTAL)

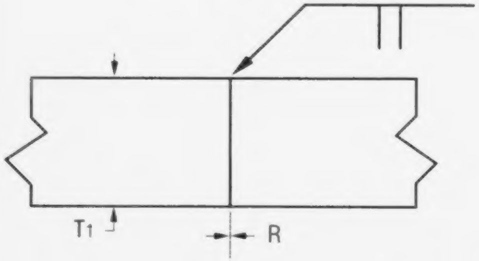


ROUND TUBING HORIZONTAL FIXED (±15°) AND NOT ROTATED DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

TEST POSITION 5G (MULTIPLE)

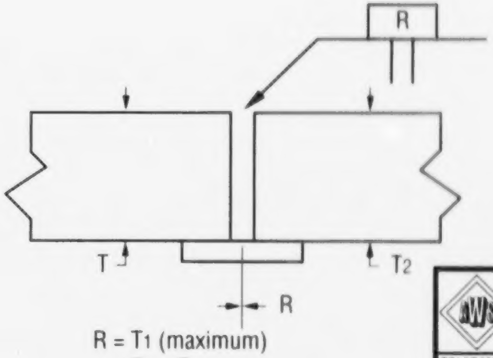
Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GTAW of aluminum round tubing.
2. 1" – 2-7/8" Ø, 10 ga. - 18 ga. aluminum round tubing (M-22/P-22/S-22 to M-22/P-22/S-22) or (M-23/P-23/S-23 to M-23/P-23/S-23). Optional choice of diameter, wall thickness and material within range specified.
3. The standard round tubing groove test weldments for performance qualification shall consist of two round tubing sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With or without backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Details "A" and "B".
7. Root shielding gas required.
8. All parts may be mechanically cut or machine PAC.
9. Use WPS AWS 2-1-GTAW for M-23/P-23/S-23.
   Use WPS AWS 2-1.1-GTAW for M-22/P-22/S-22.
10. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1.
    Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C.
    Bend specimens = 1/2" (13 mm) wide x 6 in (150 mm) long.



R = T1 (maximum)
T = 10 ga. through 18 ga.

(A) Joint Detail - without backing



R = T1 (maximum)
T1 = T2
T = 10 ga. through 18 ga.

(B) Joint Detail - with backing

American Welding Society

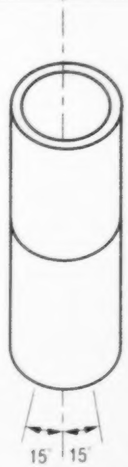
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10', -5'		Level II - Advanced Welder—GTAW — 2G, 5G — QC7 Optional Performance Qualification	
DR BY D. Cantelope	DATE 1/5/96	SIZE / QC NO 11-96 / DWG NO AWS2-4-9	REV
CHK BY R.V. Reeve	DATE 1/6/96	APPROVED AWS-EGC DATE 1/31/96	SHEET 1 of 1

Figure 17 – Level II – Advanced Welder, QC7 Optional Performance Qualification, GTAW Stainless Steel Round Tubing.

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

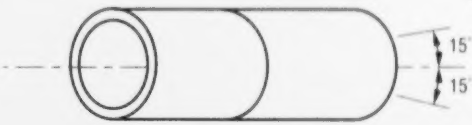
REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



ROUND TUBING VERTICAL AND NOT ROTATED DURING WELDING. WELD HORIZONTAL (±15°).

TEST POSITION 2G (HORIZONTAL)

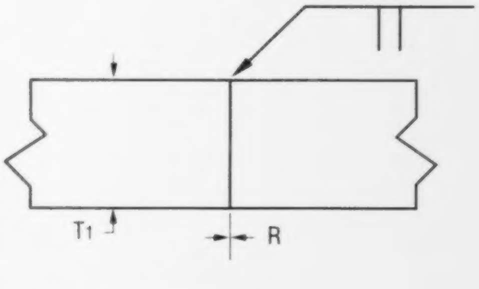


ROUND TUBING HORIZONTAL FIXED (±15°) AND NOT ROTATED DURING WELDING. WELD FLAT, VERTICAL, OVERHEAD.

TEST POSITION 5G (MULTIPLE)

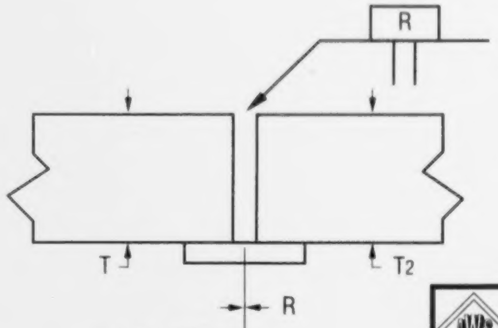
Notes:

1. Administration of this performance qualification test in accordance with AWS QC7, Supplement G, supersedes AWS QC11 and AWS EG3.0 requirements of Workmanship Qualification for GTAW of stainless steel round tubing.
2. 1" – 2-7/8" Ø, 10 ga. - 18 ga. stainless steel round tubing. Optional choice of diameter and wall thickness within range specified.
3. The standard round tubing groove test weldments for performance qualification shall consist of two round tubing sections, each a minimum of 3 in. (76 mm) long joined by welding to make one test weldment a minimum of 6 in. (150 mm) long.
4. Performance Qualification #1 = 2G position. Performance Qualification #2 = 5G position.
5. All welding done in position according to applicable performance qualification requirement.
6. With or without backing. Backing ring to suit diameter and nominal wall thickness of pipe. Refer to Details "A" and "B".
7. Root shielding gas required.
8. All parts may be mechanically cut or machine OFC.
9. Use WPS ANSI/AWS B2.1.009.
10. Visual examination in accordance with the requirements of AWS B2.1, sections 3.5.1 and 3.5.3.1. Bend test in accordance with the requirements of AWS B2.1, sections 3.5.3.1, 3.7.1.2 and Figure 3.7.1C. Bend specimens = 1/2" (13 mm) wide x 6 in (150 mm) long.



R = T_1 (maximum)
T = 10 ga. through 18 ga.

(A) Joint Detail - without backing



R = T_1 (maximum)
$T_1 = T_2$
T = 10 ga. through 18 ga.

(B) Joint Detail - with backing

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions: ± 1/16" Angles: + 10°, -5°

Level II - Advanced Welder—GTAW — 2G, 5G — QC7 Optional Performance Qualification

DR BY: D. Cantelope DATE: 1/5/96
SIZE:
QC NO: 11-96
DWG NO: AWS2-4-10
REV:
CHK BY: R.V. Reeve DATE: 1/6/96
APPROVED: AWS-EGC DATE: 1/31/96
SHEET: 1 of 1

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ANNEX A

Recommendations for Support Personnel and Systems

Al.0 Program Administrator.

The administrator, director, or supervisor of any welding program should be familiar with all types of welding. A practical background in the welding industry would be very helpful. In addition to meeting the minimum state certification requirements, the program administrator should be experienced in both instruction and program execution.

Because of the importance of continued contact with area industry, the administrator should be encouraged to join and maintain a membership in the American Welding Society and be active in the local AWS Section. Membership in other professional organizations, particularly in the materials (metals) or educational field, would also be very helpful. Such participation will allow a welding program administrator to maintain effective working relationships with members of local industry, technical experts, and fellow educators. Moreover, the administrator's commitment to these activities sets the example for not only the instructors but also the welding personnel.

A2.0 Business and Industry Services Liaison (BISL).

A full time liaison with no other responsibilities, representing the schools' vocational trades interests should be established. This individual should be a certified staff member with previous experience as a cooperative vocational education coordinator or a guidance counselor with job placement background. This individual should also have a strong understanding of both education and work environments. The responsibilities of the position should include:

- Formation of a Business & Industry Services Unit
- Identification of prospective trainees
- Assisting students to successfully fulfill all the proposed school requirements
- Administration and maintenance of records, coordination of student placement
- Conducting follow-up trainee surveys
- Teaching of the employability skills curriculum
- Maintaining close cooperation with the Advisory Council or Private Industry Council

The "*BISL*" is the direct contact with the Advisory or Private Sector Coordinator.

A2.1 Business and Industry Services Unit (BISU).

A team of professionals from the BISU coordinates the trades initiative. Under the direction of the Business Industry Services Liaison (BISL), the unit serves as the in-school component, for implementing a series of coordinated activities on a daily basis, designed to assist trainees, to acquire prerequisite skills and experiences needed to secure and retain full time employment upon graduation of their respective programs. The unit coordinates its activities with the Advisory Council. The BISU should consist of:

- Business Industry Services Liaison
- Site Principal or President
- Basic Skills Coordinators
- Bilingual and/or ESL Coordinators
- Guidance Staff
- Vocational Education Coordinator

The "*BISU*" has the responsibility to coordinate and conduct activities for:

- Assessment and interpretation of a trainee's interests and abilities with employment services
- Providing career seminars for trainees
- Maintaining a career resource center
- Delivering a computerized guidance information system
- Activating parent groups
- Implementing shadowing, internship, and apprentice experiences for students
- Developing part-time/summer job placement and full time job placement
- Conducting program evaluations
- Developing trainee career profiles
- Development of a yearly action plan
- Meeting monthly to discuss each trainee
- Developing individualized instruction to assist each participant to complete program requirements
- Developing activities in coordination with members of the Advisory Council to implement program objectives
- Plan meetings with the Advisory Committee on a periodic (quarterly) basis

A3.0 Advisory Council.

The Council comprises a group of selected individuals based on their knowledge and expertise to advise those involved in the training initiative on: current labor needs, development of relevant courses/programs, and the competencies offered in each of the courses or programs. This unit in not housed within the confines of each training system, but its members are called upon frequently to assist in the development of individualized student programs. The Advisory Council consists of:

- Private Sector Coordinator (representing either JTPA or PIC)
- Job Placement Coordinator
- District Curriculum Coordinator (for grades 7–12)
- Employment Service Representative
- Parent (PTA/PTO) Representative (secondary institutions)
- Business and Industry Representative
- Organized Labor Representative
- Military Representative (for areas of civilian employment served by the Armed Forces)

A4.0 Private Sector Coordinator.

The Private Sector Coordinator is a full time employee of the State Department of Labor (JTPA/PIC) located within each program service delivery area. Private Sector Coordinators work closely with business and industry to develop part time/summer and full time jobs, as well as compile and update jobs. These jobs are then provided to the employment service for use in a computerized job bank to match identified eligible trainees to summer and full time jobs. The Private Sector Coordinator's function is to:

- Develop cooperative agreements with the training facilities of their designated areas (terms for state program funding)
- Offer liaison with all schools or training facilities within their jurisdiction
- Be responsible for bringing together representatives of business and industry

- Report to the Private Industry Council (PIC) director/chairman of their designated area in carrying out the terms of the cooperative agreement (JTPA) or similar state and federally administered models
- Coordinate PIC and LEA (school board) groups to assist eligible youth with the opportunity to participate in other services provided by the Private Industry Council (tuition refunds, travel allowances, food, clothing, tools, etc.)

A5.0 Advisory Committee.

The Committee is a conglomerate of all interested training incentive sectors. It assists in the advertisement of program implementation, formulation of trainee learning contracts, informing training facility personnel and the community about the program, providing orientation for potential training candidates, their spouses and or parents, planning and implementing "launching" activities, review of final reports and evaluations, and the review of follow-up surveys. The Committee is comprised of:

- Business Industry Services Liaison (chairperson)
- Local section representative of the American Welding Society (AWS),
- Assistant Superintendent of Schools or Assistant President of the College Board of Regents
- Human Resource Development Director or Director of Guidance
- Cooperative Education Coordinators
- Parent Representative (secondary systems)
- Trainee Representative (Level - II, should have an active voice in training)
- Members from a school district offering a comprehensive welding curriculum
- Community Agency Representatives
- Business and Industry Representatives:
    Welding Engineer
    Welding Inspector
    Welding Technician
    Welding Supervisor
    One or two experienced welders
    Welding supply representatives
- Private Industry Council Representative
- State Employment Representative

The duties of the Advisory Committee may vary according to the preferences and composition of the representatives from the geographical area and various state models. However, the baseline duties should include the following:

- Providing advice and assistance in the selection, purchase, and installation of equipment appropriate to both the instructional environment and the requirements of modern industry.
- Assisting in the development and implementation of continuing education experiences, including advanced course work, for welding educators.
- Assisting with the preparation and review of instructional materials and the ongoing development of instructional pedagogy.
- Fostering participation in appropriate community service and educational projects, stressing the value of such activities as an excellent means of recruiting and motivating individuals.

- Encouraging welding personnel to apply for scholarships and enter competitions sponsored by such entities as the American Welding Society (AWS), Vocational Industrial Club of America (V.I.C.A.), and other educational opportunities.
- Helping with follow-up surveys of graduates who have been successfully placed in welding-related occupations.
- Supporting the program through assistance in public relations and welding personnel recruitment.
- Sponsoring career days, plant tours, and related activities designed to stimulate interest in welding and related fields as possible career opportunities.
- Provide assistance in obtaining welding practice materials.
- Provide internship opportunities in area businesses.

A6.0 AWS Certified Welding Educator (AWS QC5).

The Welding Instructor is a person who recognizes welding training requirements, prepares instructional plans, conducts training classes and evaluates welding personnel performance. This instructor may teach using prepared instructional materials or prepare original instructional materials. Most states require instructor certification which includes meeting selective academic standards and demonstrating experience from that related industry.

The instructor should be certified by AWS QC5, *Standard for Certification of Welding Educators*. The instructor should also be certified by AWS QC7, *Standard for AWS Certified Welders* in the processes, positions, base metals, and filler materials involved with the courses being taught.

Instructors should be responsible for continually updating their technical knowledge. Furthermore, it is incumbent upon welding instructors to strive to enhance their own teaching abilities. Welding instructors will find participation in the programs of appropriate industry and educational associations beneficial to their effectiveness as educators. On a regular basis, instructors, as members of AWS, should visit local industry, attend area welding educational programs sponsored by local AWS sections and/or the annual AWS International Welding Exposition in order to stay up–to–date on the latest technological trends. Industry and trade magazines provide another excellent means of continuing education and many are available to educators free of cost. Attitude, demeanor, and dedication to the welding industry are essential qualities as instructors set the example for their welding students.

A7.0 AWS Certified Welder Program (AWS QC7).

The primary program for Level II – Advanced Welder Training is AWS QC11, Specification for Qualification and Certification for Level II – Advanced Welder. The AWS Certified Welder program is for advanced trainees and experienced welders seeking certification to a particular welding code as AWS Certified Welders.

The American Welding Society (AWS) Certified Welder Program was established to identify all elements necessary to implement a National Registry of Certified Welders. The four key elements of this standard (AWS QC7, Standard for AWS Certified Welders) include:

- Welder performance qualification standards
- Standard welding procedure specifications
- Accredited performance qualification test facilities
- AWS welder certification requirements

The QC7 standard contains the criteria for the AWS Certified Welder Program and the AWS National Registry of Welders. The purpose of this standard is:

- To determine the ability of welders to deposit sound welds in accordance with standardized requirements.
- To impose sufficient controls on the documentation and maintenance of certification to allow transfer between employers without requalification, where allowed by standard or contract documents.

Applicants, upon successful completion of qualification testing, become certified, and are issued an identification/qualification limits card encased in plastic. This identification/qualification limits card shall be used to identify certified welders and their limits of certification. The AWS certification of a welder is effective for a period of one year from the date of certification. Prior to the end of the certification period, an application for recertification may be made if:

- The welder retests
- The welder submits form QC–WF3 attesting to having welded satisfactorily in each six month period of the one year with the processes qualified for.

A8.0 AWS Accredited Test Facilities (AWS QC4).

AWS Accredited Test Facilities are designed to implement the QC7 program. Under this program instructors may not test and qualify welders they have trained. In the QC11 program for advanced welders, instructors are afforded the latitude of training, testing and qualifying trainees if the code/standard qualification option ***is not*** *exercised.*

AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program*, establishes minimum requirements for Test Facilities, their personnel, and equipment to qualify for accreditation to test and qualify welders in the AWS Certified Welder Program. This facility accreditation program is open to all Test Facilities that are qualified, whether or not they are members of AWS. The Test Facilities may be part of an independent laboratory, manufacturing plant, educational institution, or other party.

The purpose of a third-party accreditation of Test Facilities for welder qualification is to confirm that a Test Facility has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to conduct proper welder qualification testing for the AWS Certified Welder Program. AWS QC4 describes the requirements and functions of the Test Facility to achieve this purpose and to complete reliable reports and to define the relationships between the Test Facility and the other parties involved.

The AWS Accredited Test Facilities conduct welder qualification tests for the AWS Certified Welder Program. A person wishing to take tests to become an AWS certified welder prepares an application in accordance with AWS QC7. The applicant is responsible for contacting the Test Facility to arrange a specific date and time for the completion of the qualification test assembly. All acceptable test results and records will be forwarded to AWS by the Test Facility after the welder qualification test is completed.

A9.0 Safety Requirements.

All schools shall develop and enforce sound safety programs, beginning with the orientation of welding personnel and continuing through graduation. Each school shall teach safety theory and practice safety at all times. All safety practices shall conform to local, state, and federal regulations, and ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*; ANSI/AWS F2.2, *Lens Shade Selector*; ANSI/AWS F3.1, *Guide for Welding Fume Control*; ANSI/AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers That Have Held Hazardous Substances* and general work place safety.

A10.0 Evaluations.

The purpose of the evaluation program is to directly and efficiently respond to the identified needs of:

- Diverse trainee populations
- Corporate training institutions
- The communities and industries served

Responding to these needs improves each trainee's opportunity for access to training and increasing the numbers of students completing training objectives related to the service needs of the employing community.

The process should include administering diagnostic assessment instruments to determine the prospective training clients' current knowledge, attitude, skills, and habits (KASH) as contrasted to the clients initial career interest. In addition, this evaluation should define and implement duties, role relationships and tasks of the instructional and supportive advisement staff to deliver appropriate services generated from the diagnostic assessment system.

As each step of training is completed, the results of both written and performance tests should be communicated to each individual and duly recorded in an appropriate format. The number of hours of welding theory and practice completed, by process, should also be recorded. The purpose of this information is to develop a career profile for each trainee.

The program evaluations should be three-phase:

- **Formative:** To measure learning progress at each step of the program and provide diagnostic prescriptions for learning problems that require remedial work.

- **Summative:** To determine if the learner has mastered the learning tasks to such a degree that he/she may move to the next course, unit or level of instruction, and to determine some type of grade assignment.

- **Follow-up:** To measure the trainee's effectiveness on the job and the training facility's delivery of the instructional programs. Follow up evaluation is meant to determine whether the school or facility has met the needs of industry. Follow-up surveys are used by the Advisory Council and Advisory Committee to track program performance and to make prescriptive recommendations for weak training areas.

ANNEX B
Recommendations for the Trainee Population

B1.0 Entrance Requirements.

B1.1 Career Guidance.

The success of recruiting prospective individuals into the welding field will depend on the pre-placement assessment, testing and guidance provided to that individual. The Business Industry Services Unit personnel should emphasize the very real opportunities inherent in choosing welding as a career path. Current and long-term needs for skilled welders demand that career counselors present welding as a positive career. Business Industry Services Unit personnel and the Advisory Committee members play an important role in ensuring that career counselors and the administrative committee have regular, positive contact with the welding industry through plant tours, open houses, and personal contacts. Guidance counselors must be made aware that welding not only provides an excellent entry level career, but can also provide preparation for positions such as welding supervisor, quality assurance inspector, production scheduler, etc. Moreover, career enhancement should not cease once training is completed. The Instructors and the Advisory Committee should work with the Business Industry Services Unit to place graduates in appropriate positions and to track their subsequent successes.

B1.2 Basic Prerequisites.

Standards for admittance to the welding program should be established by formal evaluation of prospective welding personnel. A basic foundation in computation, physical science, learning to learn, reading, writing, problem solving abilities, creative thinking, interpersonal skills and teamwork is necessary if a person is to have a successful career in welding. In the event that some prospective welding personnel do not demonstrate the academic skills necessary to understand the subject matter, a "remedial" program, at the same location or nearby training facility, should be set up to provide the missing academic foundation necessary for welding training.

B1.3 Aptitude.

Each training program should incorporate some form of pre-placement test(s) to help screen and orient prospective welding personnel. There should be some form of diagnostic assessment and academic advisement. Whether or not they are used specifically for screening, a welding aptitude test can provide valuable insight into an individual's unique educational abilities and needs. As an example, welding simulators are one aid available to assist in this determination. Both written exercises and tests for manual dexterity, should be considered when evaluating the prospective individual's overall aptitude.

B1.4 Health.

Safe operation of the welding equipment and maintaining a work environment appropriate to the welding industry are paramount. Prospective welder trainees should have the ability to meet these critical requirements.

B1.5 Age.

Individuals must meet the minimum age requirements stipulated by applicable state and federal laws.

B1.6 Probationary Period.

All trainees should be given a trial period in which to demonstrate their ability to perform, and develop good work habits as required by industry. The time limit for such a period will vary according to the institution and type of instruction, but should not exceed 15 percent of the course length. A public school situation may permit a longer time, versus that allowed by a private or industrial training program. During this probationary period, the educator must determine whether, in the interests of all concerned, the individual should continue the course of instruction.

B2.0 Trainee/Instructor Ratio.

The trainee–instructor ratio for each course should be kept as low as possible. A reasonable figure would be fifteen (15) welding personnel to one (1) welding instructor. However, this ratio should never exceed the number of work stations in the laboratory. Twenty (20) welding personnel to one (1) instructor would be the maximum acceptable ratio.

B3.0 Trainee/Machine Ratio.

Only one (1) individual should be assigned to a power source at a time. Placing more than one (1) individual in a booth or work station is unacceptable for positive training, disciplinary purposes, and safety.

ANNEX C
Recommendations for Facility Planning

C1.0 School Facilities.

C1.1 Primary Structure(s).

The building should be fireproof and well designed. Welding instructional facilities will function best if located on the ground floor, preferably in a one story wing of the main building or in a separate building with covered access ways. Instructional areas in which noisy activities are conducted are best placed farthest from other academic areas of the school or production areas in an industrial facility. Walls should be smooth, with no ledges to collect dust. Floors must be fire resistant, waterproof, and contain adequate floor drains. A minimum light level of 100 foot-candles (100 candela) 30 inches (762 millimeters) from the floor is recommended. To enhance motivation and morale, adequate natural light from windows and skylights should be available. Walls should be prepared with a low reflective paint to reduce ultraviolet radiation. "Cool" colors, blues or greens, are recommended. The various work stations in a laboratory should meet the following objectives:

- Provide suitable facilities where the instructor may demonstrate the skills and techniques necessary to develop welding competencies.
- Provide a place at which the welding students may develop such competencies.
- Provide an area in which power sources, equipment and projects may be secured and serviced.
- For specific industry welding training facilities, provide special fixturing and production work mock-ups to adequately demonstrate the production work to be expected in order to all students to experience typical job related welding positions, conditions, and interferences.

A modular system of layout should be considered so that a two fold criteria for modern building planning (i.e., flexibility and expandability) can be achieved. The former is accomplished by allowing the maximum possible interchange of work stations and other facilities. Future expansion is planned in terms of multiples of specific work stations needed rather than in terms of the general area to be added. These features would simplify the work of the architect, increase the usable life of the laboratory, and provide the instructor with more possibilities to offer Curriculum changes.

The flexibility and expandability of laboratories should be greatly enhanced if architectural design permits use of nonload-bearing partitions between adjoining areas. Good planning includes the provision of doors large enough to permit easy entry of the largest piece of equipment into each shop. In addition, placement of such doors to permit the maximum degree of future flexibility with changes in partition locations should be considered.

If facilities are to be used for evening classes, easily accessible outside entrances which eliminate the necessity of opening or lighting other parts of the building offer important savings in operating and maintenance costs.

C1.2 Classroom(s).

Ideally, a room for instruction should be about 20 feet (6.1 meters) X 24 feet (7.3 meters) and adjacent to the laboratory. Classrooms should provide a clear (but protective) view of the laboratory area. The minimum ceiling height should be 12 feet (3.7 meters) or higher. Classrooms must be acoustically insulated from laboratory noise. This space should have chalk and tack boards, a demonstration table, adequate seating facilities and provision for darkening for the use of visual aids. At least one bulletin board should be near the main entrance. Instructors and welding personnel must have nominal access to the classroom. Storage for audiovisual equipment, charts, models, samples, reference texts, etc., need to be provided. Exhibit cases have strong appeal to parents and observers, especially when located to permit viewing from the outside corridor.

C1.3 Laboratory.

A minimum of 100 square feet (9.3 square meters) of laboratory floor space per individual is considered a good general planning figure, exclusive of washroom, storage, office space and the classroom. At the outset the architect and laboratory planner must take into account state recommendations as to minimum square footage per individual. While they vary from state to state, factors of 75 square feet (7.0 square meters) to 150 square feet (13.9 square meters) of work space per individual and a minimum of 400 square feet (37.2 square meters) to 800 square feet (74.3 square meters) for material storage are generally accepted requirements for this particular size area and the subjects to be taught. Floor dimensions of 40 feet (12.2 meters) X 85 feet (25.9 meters) are reasonably close to the normally accepted length to width proportions of 2 to 1. The minimum ceiling (clearance) height should be no less than 14 feet (4.3 meters). At least one entrance must be large enough (14 feet (4.3 meters) X 14 feet (4.3 meters)) to accommodate bulky materials, equipment and projects. Future expansion should always be considered. While projections of this nature are sometimes only educated guesses at best, adaptability for reorganization should be kept in mind. This should permit additional enrollment, new equipment, or extra shop Subjects to be reasonably accommodated without going below space–per–individual minimums.

Where a hazard exists around machines, the power equipment should be so placed that welding personnel are not in the line of danger. Added protection is given by enclosing this equipment in a safety zone painted on the floor. Wide aisles of travel should be provided between benches, machines, and in areas in front of tool cabinets and storage lockers. These aisles should be a minimum of 3 feet (.9 meters) in width. Aisles of travel may be designated by painted lines similar to those used in industry. Non-skid surfaces such as sand on shellac should be applied to the floor in the area around machines to minimize danger of slipping.

A 6 feet (1.8 meters) X 6 feet (1.8 meters) area should be planned for process booths and ought not to contain a power source. Welding booths must be constructed of fire resistant material, with the walls open at least 12 inches (305 millimeters) at the bottom to permit air circulation. All four sides of the welding booth should provide complete protection to the welding personnel and others in the area from harmful rays and hot sparks. A minimum of one (10 feet (3.1 meters) X 10 feet (3.1 meters)) demonstration area should be available for every 20 welding personnel. Positioning jigs, independent of other activities to prevent congestion, should be provided.

Tools and supplies should be located as near to work areas as practical to reduce travel and interferences. Machines should be placed to allow for ease of cleaning around the base. Cabinets should fit flush to walls or be trimmed to fit flush for the same reason. Bases for cabinets and benches should provide toe space for comfort and safety of workers.

C1.4 Office(s).

The entrance to the instructor's office should be easily accessible from the classroom, laboratory and facility corridor. Activities in the classroom and laboratory must be visible from the office. The office window space should be designed to provide maximum vision to all areas along with proper ultra violet light protection. The office ought to provide at least 120 square feet (11.2 square meters) of floor space per instructor [size 10 feet (3.1 meters) X 12 feet (3.7 meters)]. The office needs to be planned with at least one 3 foot (.9 meters) wide door, tile or carpet flooring cover, and an acoustical ceiling with fluorescent lighting. For instructional use and laboratory safety the office should have a telephone. It should also have room for file cabinets, desk, bench with storage underneath for weld supplies, a shelf for boots, and room for two chairs for counseling welding personnel.

C1.5 Storage.

Decentralized storage should help conserve space and increase efficiency by reducing individual traffic. A storage area for bar stock should be at least 20 feet long (6.1 meters) and 7 feet wide (2.1 meters), with a door centered at both ends. This permits both economical purchase of steel in long lengths and wall storage within the room. Use of horizontal or vertical racks depends on space limitations and personal preference. Storage of bulk supplies (adequately secured) should be located adjacent to an outside service door for convenient delivery.

Adequate filler metal storage should be considered and should be controlled. Rod, wire, and fluxes, depending on their nature, must be maintained under certain storage conditions. The materials of higher value or requiring temperature control should require the tighter controls to ensure that product quality is retained. Acquisition of a specially designed electrode storage oven is highly recommended.

Open tool cabinets in each process area should conserve welding personnel time and travel while helping them associate proper tool selection and application with a particular activity. This also provides for easy checking of tools. Space underneath benches and tables is excellent for storage of hardware, small amounts of raw stock or even small projects. Storage for projects of welding personnel and personal belongings is always a problem and should be well thought out.

Cylinder storage should be located near the laboratory, but accessible to truck traffic. All volatile materials) should be stored outside in an identified, isolated area to minimize the potential hazards involved. Cylinder storage **shall** follow the guidelines set forth in ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II Specific Processes, 10.8.2 Cylinder Storage.

One door should open directly to the outside from this room so that stock may be loaded into the room with no interference to shop activities. Scrap storage could be located near this entrance. Thus, material storage areas or rooms should be located conveniently for issuing materials to the welding personnel, for cutting large stock to project size and for the unloading of delivery trucks.

C1.6 Personal Services.

Personal Services should be planned into the laboratory, both for convenience and efficiency. Individual lockers for books and clothing should be near the entrance to keep these items out of the main instructional area. A wash-up sink and water fountain and, where possible, a lavatory (for both genders) should also be included near the entrance.

C1.7 Budget.

Adequate financial resources should be considered and support provided to not only maintain the program, but also enhance it. Funding for power sources, filler metals, gases, and fluxes along with power equipment and hand tools are just the basics. Additional monies should be available to provide the materials necessary for adequate welding instruction. As necessary, staff and faculty should also have included in the budget resources (i.e., release time and dollars) to provide for their technical as well as professional development.

C1.8 Lighting.

100 foot-candles (100 candela) should be the absolute minimum recommended for general work in any shop while 140 foot candles (140 candela) would be recommended for more difficult or inspection work. In most cases, the use of indirect lighting to avoid glare and evenly diffuse the light is recommended. When needed, individual machines can be lighted by lamp attachments or through their

own built-in lighting systems. Providing uniform distribution of shadow-free light through the use of indirect or semi-indirect deflectors should also be considered. Adequate lighting shall also be found in each booth.

C1.9 Electricity.

Electrical power should be supplied with adequate voltage and amperage for each power source. Electrical service should be 208 volt, 230/240 volt or 460/480 volt, single-phase or three-phase, and 60/50 cycle (60/50 Hertz), alternating current. The primary service should never be less than 208 volts. Current capacity of 75 percent more than the known demand should be provided for expansion in the welding facility. Electrical outlets for 110/120 volt service should be placed at convenient locations every 12 feet (3.7 meters) and in every booth. Ground fault interrupters should be provided throughout the shop. The use of magnetic starters on all equipment is an additional safety feature which gives a machine motor overload protection as well as low-voltage, and no-voltage protection. After a power failure has been corrected, the machine will not start (even if it was running when the failure occurred) until the operator presses the start button.

A disconnect switch that can be locked out, must be provided to cut off all power equipment, including power sources in the shop. Panic switches should be strategically located around the entire shop or laboratory and their locations known by all welding personnel. They should be wired to cut off power to every machine. Fused disconnect switches should be provided for each power source and there should be no exposed wiring.

C1.10 Ventilation.

Individual, movable exhaust hoods are highly desirable at the work site. Welding station exhaust should be separate from other laboratory exhaust systems. The minimum required air velocity at the zone of welding is 100 feet per minute (.5 meters per second) when the hood is at its farthest position from the joint being welded. The hood size and height could be reduced to lower the required capacity of the exhaust system. The use of a qualified heating, ventilation, and air conditioning (HVAC) contractor is strongly recommended, rather than having a inexperienced sheet metal firm perform the construction. Fire resistant, safety yellow, strip curtains could be lowered to form a booth when greater exhaust efficiency is desired at the demonstration area.

For the single welding booth, it is practical to design a hood exhaust system. When there are a large number of booths being used, it is more practical to provide exhaust at the arc than for the entire room. However, the loss of heat during the cold months is a serious objection to the room ventilation method unless a heated air intake system is used. To avoid this heat loss, electronic precipitators, which clean the exhausted air and reintroduce it back into the laboratory to save heat and air conditioned air, should be used. These units need careful placement as welding schools create more smoke than most industry applications due to large numbers of units in a contained work area.

C1.11 Heating.

Heating and cooling capacity must take into consideration the provision for a supply of fresh, clean incoming air. The laboratory heating system should automatically maintain a temperature of 68° Fahrenheit (20° Celsius) measured 60 inches (1.5 meters) above the floor. The classroom and the office should be kept at 70° Fahrenheit (21° Celsius) measured 30 inches (762 millimeters) above the floor. A system of even heat distribution should be kept within 5% of these temperatures for health reasons and for stability of equipment and stored materials.

C1.12 Water.

Hot and cold running water, with suitable drinking fountains in the laboratory, and convenient sanitary restrooms are necessities. Washing facilities of either the half round or trough type sink are essential and, as a rule of thumb, should be adequate to accommodate one quarter of the welding personnel simultaneously. Location of the washing facilities should be as near the door as feasible. Drinking fountains are highly desirable and should be available within the welding facility. A safety shower and eye wash station should also be located within each laboratory area. Proper drainage must be considered during installation.

C1.13 Safety.

Information regarding safety can be found in ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*; ANSI/AWS F2.2, *Lens Shade Selector*; ANSI/AWS F3.1, *Guide for Welding Fume Control*; AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers That Have Held Hazardous Substances*, as well as all other applicable local, state and federal regulations. Equipment must conform to the OSHA requirements for "lockout and tagout."

All safety features of the primary structure(s) and its support system(s) must conform to any local, state or federal governing codes. The school must be able to pass an inspection of the local and state Fire Marshal and possess a certificate of conformance from the regional OSHA engineer.

C2.0 Equipment and Supplies.

C2.1 Instructional Equipment.

C2.2 Welding/Cutting.

The total number of welding work stations should exceed the number of welding personnel enrolled. Ideally, there should be 25 percent more welding stations than there are welding personnel, in order to provide for expansion of enrollment. Most of the stations should be equipped with multi-process power sources. Since SMAW is the most popular welding process, it and at least one other joining process should be linked together.

C2.2.1 Arc Welding.

At least thirteen (13) combination constant current/constant voltage power sources for SMAW, GMAW, GTAW, and FCAW, and thirteen (13) constant current AC/DC power sources with high frequency for GTAW should be provided for every 20 welding personnel. Local industry and adult extension classes may dictate modifications to this structure.

Power sources for SMAW, and GTAW should have a minimum rated output of 60% duty cycle at 300 amperes. Power sources for GMAW and FCAW should have a minimum rated output of 100% duty cycle at 300 amperes. Power sources must be installed in accordance with the National Electrical Code, and be equipped with work leads, electrode holders, guns and/or torches.

An engine driven welder (1) per school should be adequate with both constant current and constant voltage output. Minimum rated welding output should be 200 amps cc/cv at 60% duty cycle. The fuel supply can be gasoline, diesel or propane.

C2.2.2 Oxyfuel Gas Cutting and Welding.

Five (5) oxyfuel gas cutting/heating/welding torches should be provided for every 20 welding personnel. It is recommended that one (1) oxyfuel gas cutting machine be made available for demonstration and instruction. All oxyfuel gas equipment should be of industrial quality and should be appropriate for the thickness of the material being utilized in the instructional program. A distribution system for piping gases to work stations is recommended, along with one (1) portable cylinder set up per 20 welding personnel. This will facilitate instruction in safely setting up and changing compressed gas cylinders. Flashback arrestors must be provided.

C2.2.3 Plasma Arc Cutting (PAC).

Two (2) plasma arc cutting machines should be provided for every 20 welding personnel. Equipment that utilizes compressed air is recommended for cutting. Plasma arc gouging is also a recommended feature. Optional compressed gases can be available, but are not a mandatory part of the cutting package. The plasma arc power source and torch should be rated to cut a minimum of 1/2 inch (12.7 mm) carbon steel at 10 inches (254 mm) per minute travel speed. The plasma arc power source should should have a minimum rated output of 60% duty cycle at 300 amperes.

C2.2.4 Air Carbon Arc Cutting (CAC–A).

Two (2) cutting/gouging torch should be provided for every twenty (20) welding personnel. CAC–A equipment uses compressed air for either cutting or gouging. The torch and machine should be rated to cut/gouge a minimum of 1 inch (25.4 mm) carbon steel at 10 inches (254 mm) per minute travel speed. The CAC–A power source should have a minimum rated output of 60% duty cycle at 300 amperes.

ANNEX D
Recommendations for Personal and Shop Materials, Equipment and Tools

INDIVIDUAL EQUIPMENT and TOOLS

Personal protective clothing and equipment

- ☐ suitable work clothing (to match service conditions for welding process employed, must be fire resistant)
- ☐ leather jacket, cape, sleeves or apron (optional)
- ☐ leather gloves
- ☐ hightop leather safety shoes or boots (steel toed are recommended)
- ☐ welders hat or skullcap
- ☐ spectacles w/side shields (clear lens)
- ☐ burning goggles or face shield (OFC & PAC)
  - ☐ 2 ea. #5 filter plate/lens
  - ☐ 2 ea. #7 filter plate/lens
  - ☐ 4 ea. clear cover plate/lens
- ☐ noise protection (ear plugs)
- ☐ welding helmet
- ☐ welding lenses (to match helmet design)
  - ☐ 2 ea. #10 shaded filter plate/lens
  - ☐ 2 ea. #12 shaded filter plate/lens
  - ☐ 4 ea. clear cover plate/lens

Personal tools

- ☐ carbon steel wire brush
- ☐ stainless steel wire brush
- ☐ 16 ounce ball peen hammer
- ☐ soap stone
- ☐ center punch
- ☐ metal scribe
- ☐ steel dividers (radius maker, min. 6")
- ☐ handheld calculator
- ☐ measuring devices
  - ☐ steel tape measure (minimum 10')
  - ☐ combination square set
  - ☐ english/metric steel bench rule (min. 12")
- ☐ chipping hammer
- ☐ 10" mill file (half round–bastard cut)
- ☐ cold chisel (size optional)
- ☐ pliers, wrenches and clamps
  - ☐ 12" adjustable wrench
  - ☐ tank wrench (optional)
  - ☐ 10" groove or slip joint pliers
  - ☐ 6" side or diagonal cutting pliers
  - ☐ 6" needle nosed pliers
  - ☐ 10" vise grips; 10" vise grip clamp
  - ☐ allen or hex wrench set (to 3/8")
- ☐ screwdrivers
  - ☐ flat head
  - ☐ phillips head
- ☐ oxyfuel friction lighter, flints and tip cleaners
- ☐ flashlight
- ☐ fillet gage

EQUIPMENT and TOOLS

- ☐ first aid kit
- ☐ eye wash station
- ☐ chemical shower

- ☐ fire extinguisher
- ☐ bench vise (medium duty)
- ☐ 4 ea. 8" c–clamps
- ☐ grinders (2ea.) and accessories
  - ☐ 4", 41/2" or 5" right angle grinder
  - ☐ 7"/9" right angle grinder
  - ☐ 25 ea. grinding wheels (general purpose and aluminum)
- ☐ needle gun or scaler
- ☐ 1 set adjustable wrenches
- ☐ 1 set allen or hex wrenches (to 3/8")
- ☐ 1 set screwdrivers (flat and phillips head)
- ☐ 1 set vise grips
- ☐ steel topped layout or work bench (4'x8'x31")
- ☐ oxyfuel burning table with dross pan and replaceable slats (4'x8'x31")
- ☐ work area protective screens (as required)
- ☐ ventilation equipment
- ☐ electrode oven
- ☐ guided bend test jig or machine
- ☐ compressed air supply and accessories (minimum delivery 80 psi @ 8 cfm per station)
  - ☐ 1/2" compressed air hose (length optional)
    compressed air regulator (to match system output)
  - ☐ M/F quick couples and adaptors (to accommodate pneumatic tools or air carbon arc cutting torch
  - ☐ hose repair kit with crimping tool
- ☐ arc welding/cutting power source(s) and accessories

Note: *Selection of a single multipurpose power source able to meet all welding needs with respect to process, method of metal transfer and materials is limited. Given this limitation, a combination of power sources may be necessary to meet Level II – Advanced Welder training needs. All shielding gases should be welding grade.*

- ☐ shielded metal arc
  (minimum rating – AC/DC – constant current (CC) 300 amp @ 60%)
  - ☐ 25' 2/0 electrode cable
  - ☐ 25' 2/0 workpiece cable
  - ☐ 2/0 cable lugs and connects (to suit)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ electrode holder (to 3/16" capacity)
- ☐ gas tungsten arc
  (minimum rating AC/DC – constant current (CC) 300 amp @ 60%)
  - ☐ high frequency control
  - ☐ gas purge control (optional)
  - ☐ remote control (optional)
  - ☐ water circulation and control (optional)
  - ☐ torch (25', amps and cooling to suit)
    accessory kit (to suit)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ part repair/replacement kit (to suit)
  - ☐ flow meter(s) (argon, helium service)
- ☐ air carbon arc
  (minimum rating – AC/DC – constant current (CC) 300 amp @ 60%)
  - ☐ 25' 2/0 electrode cable
  - ☐ 25' 2/0 workpiece cable
  - ☐ 2/0 cable lugs and connects (to suit)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ torch (light – medium duty)
- ☐ gas metal arc (spray and short circuit)
  (minimum rating – DC – constant voltage (CV or CP) 300 amp @ 100%)
  - ☐ 25' 2/0 electrode cable
  - ☐ 25' 2/0 workpiece cable
  - ☐ 2/0 cable lugs and connects (to suit)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ wire feeder (to suit power supply and wire diameter)

  - ☐ gun (15', amp and cooling to suit)
  - ☐ consumable parts kit (to suit)
  - ☐ parts repair/replacement kit (to suit)
  - ☐ flow meter(s) (CO_2 or mixtures Ar/O_2, Ar/CO_2)

- ☐ flux cored arc
  (minimum rating – DC – constant voltage (CV or CP) 300 amp @ 100%)
  - ☐ 25' 2/0 electrode cable
  - ☐ 25' 2/0 workpiece cable
  - ☐ 2/0 cable lugs and connects (to suit)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ wire feeder (to suit power supply and wire diameter)
  - ☐ self-shielded gun (15', amp and cooling to suit)
  - ☐ gas shielded gun (15', amp and cooling to suit)
  - ☐ consumable parts kit (to suit)
  - ☐ parts repair/replacement kit (to suit)
  - ☐ flow meter(s) (CO_2 or mixtures Ar/CO_2)

- ☐ plasma arc
  (1/2" cutting capacity)
  - ☐ **cutting** torch (25', low volt, air primary and secondary)
  - ☐ **machine cutting** torch (25', low volt, air primary and secondary)
  - ☐ workpiece clamp (amp capacity to suit)
  - ☐ consumable parts kit (to suit)
  - ☐ part repair/replacement kit (to suit)
  - ☐ air regulator (to suit)

- ☐ oxyfuel gas cutting
- ☐ **manual** oxyfuel gas cutting torch and accessories
  - ☐ cutting torch (manual or combination assembly)
  - ☐ oxygen regulator (to suit system)
  - ☐ fuel gas regulator (to suit system)
  - ☐ 25' oxyfuel gas hose
  - ☐ 4 ea. (per unit) 00 – 4/0 cutting tips
  - ☐ 4 ea. (per unit) 2/0 gouging tips
  - ☐ 1 ea. (per unit) heating tip (optional)
  - ☐ consumable parts kit
  - ☐ part repair/replacement kit (to suit)
  - ☐ cylinder cart
  - ☐ cylinder wrench
  - ☐ friction lighter, flints and tip cleaner

- ☐ machine oxyfuel gas
  - ☐ cutting machine torch assembly (to suit)
  - ☐ drive unit (track burner)
  - ☐ pipe beveling drive unit (manual or machine operated)
  - ☐ rails or track
  - ☐ oxygen regulator (to suit supply)
  - ☐ fuel gas regulator (to suit supply)
  - ☐ 25' oxyfuel gas hose
  - ☐ 2 ea. (per unit) 00 – 4/0 cutting tips
  - ☐ consumable parts kit
  - ☐ part repair/replacement kit (to suit)
  - ☐ cylinder wrench
  - ☐ friction lighter, flints and tip cleaner

  - ☐ oxyfuel gas supply
  - ☐ oxygen supply (capacity to suit)
  - ☐ fuel gas supply (capacity and type to suit)

FABRICATION EQUIPMENT (optional)

- ☐ shear 1/4" capacity
- ☐ press brake 1/2" x 8' capacity
- ☐ ironworker
- ☐ pipe/tubing bender
- ☐ pedestal grinder
- ☐ band saw
- ☐ drill press
- ☐ crane (A–frame)
- ☐ plate/sheet roller 1/2 x 8' capacity
- ☐ welding positioner
- ☐ cage, cylinder storage
- ☐ tool room, secure storage

MATERIALS

- ☐ drawings or sketches
- ☐ base metal
  - ☐ 1" carbon steel plate (optional)
  - ☐ 3/8" carbon steel plate
  - ☐ 3/8" aluminum plate
  - ☐ 3/8" stainless steel plate (optional)
  - ☐ 1/4" carbon steel plate
  - ☐ 1/4" stainless steel plate (optional)
  - ☐ 10 – 18 gage carbon steel sheet (gage size optional)
  - ☐ 10 – 18 gage stainless steel sheet (gage size optional)
  - ☐ 10 – 18 gage aluminum sheet (gage size optional)
  - ☐ useable pieces for all types material (thickness optional)
  - ☐ 4" or 6" Ø, Schedule 40 carbon steel pipe
  - ☐ 6" or 8" Ø, Schedule 80 carbon steel pipe
  - ☐ 3" Ø, 10 – 18 gage carbon steel round tubing (gage size optional)
  - ☐ 3" Ø, 10 – 18 gage stainless steel round tubing (gage size optional)
  - ☐ 3" Ø, 10 – 18 gage aluminum round tubing (gage size optional)

- ☐ SMAW filler metal
  - ☐ 100# 3/32" E7018
  - ☐ 100# 1/8" E7018
  - ☐ 100# 5/32" E7018
  - ☐ 100# 1/8" E6010
  - ☐ 100# 5/32" E6010
  - ☐ 100# 1/8" E6011
  - ☐ 100# 5/32" E6011
  - ☐ 100# 1/8" E312–15 or –16
  - ☐ 100# 1/8" E309–15 or –16
  - ☐ 100# 3/32" E3XX–15 or –16 (optional)
  - ☐ 100# 1/8" E3XX–15 or –16 (optional)
  - ☐ 100# 5/32" E3XX–15 or –16 (optional)

- ☐ GMAW filler metal and shielding gas
  - ☐ 2 spools (per unit) .035 E70S–X
  - ☐ 2 spools (per unit) .045 E70S–X
  - ☐ 2 spools (per unit) 3/64" E4043
  - ☐ 2 spools (per unit) 1/16" E4043
  - ☐ 2 spools (per unit) 3/64" E5XXX
  - ☐ 2 spools (per unit) 1/16" E5XXX
  - ☐ 100% argon (capacity to suit)
  - ☐ 75% argon + 25% CO_2 (capacity to suit) or CO_2 (capacity to suit)
  - ☐ argon + 2–5% O_2 (capacity to suit)
  - ☐ Anti-spatter spray or gel

- ☐ FCAW filler metal and shielding gas
  - ☐ 2 spools (per unit) .045 E71T–1
  - ☐ 2 spools (per unit) 1/16" E71T–1
  - ☐ 2 spools (per unit) .045 E71 T–11
  - ☐ 2 spools (per unit) 1/16" E71 T–11
  - ☐ CO_2 (capacity to suit) or 75% argon + 25% CO_2 (capacity to suit)

- ☐ GTAW electrodes, filler metal, and shielding gas
  - ☐ 4 pkg. at 10 pc. ea. 1/16" EWTh–2
  - ☐ 4 pkg. at 10 pc. ea. 3/32" EWTh–2
  - ☐ 4 pkg. at 10 pc. ea. 1/8" EWTh–2
  - ☐ 4 pkg. at 10 pc. ea. 1/16" EWCe–2
  - ☐ 4 pkg. at 10 pc. ea. 3/32" EWCe–2
  - ☐ 4 pkg. at 10 pc. ea. 1/8" EWCe–2
  - ☐ 4 pkg. at 10 pc. ea. 1/16" EWP
  - ☐ 4 pkg. at 10 pc. ea. 3/32" EWP
  - ☐ 4 pkg. at 10 pc. ea. 1/8" EWP
  - ☐ 4 pkg. at 10 pc. ea. 1/16" EWZr
  - ☐ 4 pkg. at 10 pc. ea. 3/32" EWZr
  - ☐ 4 pkg. at 10 pc. ea. 1/8" EWZr
  - ☐ 40# 1/16" ER70S–2 (carbon steel rod)
  - ☐ 40# 3/32" ER70S–2 (carbon steel rod)
  - ☐ 40# 1/8" ER70S–2 (carbon steel rod)
  - ☐ 40# 1/16" ER4043 (aluminum rod)
  - ☐ 40# 3/32" ER4043 (aluminum rod)
  - ☐ 40# 1/8" ER4043 (aluminum rod)
  - ☐ 40# 1/16" ER5XXX (aluminum rod)
  - ☐ 40# 3/32" ER5XXX (aluminum rod)
  - ☐ 40# 1/8" ER5XXX (aluminum rod)
  - ☐ 40# 1/16" ER3XX (stainless rod)
  - ☐ 40# 3/32" ER3XX (stainless rod)
  - ☐ 40# 1/8" ER3XX (stainless rod)
  - ☐ 100% argon (capacity to suit)

- ☐ CAC–A electrodes
  - ☐ 4 boxes 1/8" DC copper clad, pointed
  - ☐ 4 boxes 5/32" DC copper clad, pointed
  - ☐ 4 boxes 1/4" DC copper clad, pointed
  - ☐ 4 boxes 3/8" DC copper clad, flat

AWS LEVEL II - ADVANCED WELDER
TRAINING ACHIEVEMENT RECORD

Name: ______________________ Social Security #: ____________ Date Entered Training: ____________

Training Facility: ______________________________ Date of Completion: ____________

Address: ______________________________

____

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Telephone #: ______________________________

Course, Units and Learning Objectives	**Performance**		**Date Completed**	**Instructor's Initials**	**Trainee's Initials**
	PASS	**FAIL**			
3.2.1.1 COURSE A: OCCUPATIONAL ORIENTATION					
Unit : (no units this course) **Learning Objectives**					
(1) Follow safe practices.					
(2) Prepare time or job cards, reports or records.					
(3) Perform housekeeping duties.					
(4) Follow verbal instructions to complete work assignments.					
(5) Follow written details to complete work assignments.					
3.2.1.2 COURSE B: LAYOUT AND FITUP					
Unit 1: INTRODUCTION TO SHOP EQUIPMENT					
Learning Objectives					

Course, Units and Learning Objectives	Performance		Date Completed	Instructor's Initials	Trainee's Initials
	PASS	FAIL			
(1) Follow safe operating procedures.					
(2) Select shop equipment.					
(3) Set up shop equipment.					
(4) Operate shop equipment.					
(5) Operate lifting equipment.					
Unit 2: MEASUREMENT FOR LAYOUT					
Learning Objectives (1) Layout parts using advanced measurement practices.					
Unit 3: LAYOUT TOOLS FOR GEOMETRIC CONSTRUCTION					
Learning Objectives (1) Follow safe handling procedures.					
(2) Select layout tools.					
Unit 4: LAYOUT PRINCIPLES and PRACTICES					
Learning Objectives (1) Interpret drawing, sketch or specification information.					
(2) Prepare work area for layout.					
(3) Prepare material lists.					
(4) Select material.					
(5) Layout material.					
Unit 5: PART PREPARATIONS - CUTTING and FORMING					
Learning Objectives (1) Perform bending or forming operations.					
(2) Perform drilling or boring operations.					

Course, Units and Learning Objectives	Performance PASS	FAIL	Date Completed	Instructor's Initials	Trainee's Initials
(3) Perform shearing operations.					
(4) Perform oxyfuel gas cutting, beveling and piercing operations.					
(5) Perform arc cutting, beveling and piercing operations.					
Unit 6: FITUP PRINCIPLES and PRACTICES					
Learning Objectives					
(1) Fitup parts or assembles.					
3.2.1.3 COURSE C: DOCUMENTS GOVERNING WELDING AND WELDING INSPECTION					
Unit1: WELDING CODES and OTHER STANDARDS					
Learning Objectives					
(1) Locate essential welding information from a code or other standard.					
Unit 2: QUALIFICATION AND CERTIFICATION					
Learning Objectives					
(1) Locate essential information for welding procedure and performance qualification.					
3.2.1.4 COURSE D: INTRODUCTION TO WELDING METALLURGY					
Unit: (no units this course)					
Learning Objectives					
(1) Recognize fundamental principles related to welding metallurgy.					
(2) Recognize fundamental principles related to the properties of metals.					
(3) Recognize fundamental principles related to residual stress and distortion.					

Course, Units and Learning Objectives	Performance PASS	 FAIL	Date Completed	Instructor's Initials	Trainee's Initials
3.2.1.5 COURSE E: WELDING INSPECTION and TESTING PRINCIPLES					
Unit 1: WELDING INSPECTION AND TESTING					
Learning Objectives					
(1) Recognize the role of welding inspection and testing in industry.					
Unit 2: VISUAL EXAMINATION PRINCIPLES AND PRACTICES					
Learning Objectives					
(1) Examine cut surfaces and edges of prepared base metal parts.					
(2) Examine tack, intermediate layers, and completed welds.					
2.1.6 COURSE F: ARC WELDING PRINCIPLES and PRACTICES					
Unit 1: SHIELDED METAL ARC WELDING (SMAW)					
Learning Objectives					
(1) Perform safety inspections of equipment and accessories.					
(2) Make minor external repairs to equipment and accessories.					
(3) Set up for shielded metal arc welding operations.					
(4) Operate shielded metal arc welding equipment.					
(5) Execute corrective actions to repair surface flaws on welds and base metals.					
(6) Make fillet welds, all positions, on carbon steel or stainless steel plate using stainless steel electrodes.					
(7) Make groove welds, all positions, on carbon steel or stainless steel plate using stainless steel electrodes.					
(8) Perform an all position workmanship qualification test on plain carbon steel or stainless steel plate using stainless steel electrodes.					

Course, Units and Learning Objectives	Performance		Date Completed	Instructor's Initials	Trainee's Initials
	PASS	FAIL			
(9) Make fillet welds, all positions, on carbon steel pipe.					
(10) Make 2G, 5G and 6G groove welds, on carbon steel pipe.					
(11) Perform a 6G unlimited thickness qualification test on carbon steel pipe.					
Unit 2: GAS METAL ARC WELDING (GMAW, GMAW-S)					
Learning Objectives					
(1) Perform safety inspections of equipment and accessories.					
(2) Make minor external repairs to equipment and accessories.					
(3) Set up for gas metal arc welding operations on carbon steel.					
(4) Operate gas metal arc welding equipment.					
(5) Execute corrective actions to repair surface flaws on welds and base metals.					
Spray transfer					
(6) Make fillet welds, all positions, on aluminum plate.					
(7) Make groove welds, all positions, on aluminum plate.					
(8) Perform an all position workmanship qualification test on aluminum plate.					
(9) Make fillet welds in the 2F position, on carbon steel pipe, using spray transfer.					
Short circuit transfer					
(10) Make fillet welds, all positions, on carbon steel pipe, using short circuiting transfer.					
(11) Make 2G and 5G groove welds, on carbon steel pipe, using short circuiting transfer.					

Course, Units and Learning Objectives	**Performance**		**Date Completed**	**Instructor's Initials**	**Trainee's Initials**
	PASS	**FAIL**			
Short circuit transfer & Spray transfer					
(12) Perform a combination workmanship qualification test on carbon steel pipe & plate.					
Unit 3: FLUX CORED ARC WELDING (FCAW-S, FCAW-G)					
Learning Objectives					
(1) Perform safety inspections of equipment and accessories.					
(2) Make minor external repairs to equipment and accessories.					
(3) Set up for flux cored arc welding operations on carbon steel.					
(4) Operate flux cored arc welding equipment.					
(5) Execute corrective actions to repair surface flaws on welds and base metals.					
Self-Shielded					
(6) Make fillet welds, all positions, on carbon steel pipe, using self-shielded electrodes.					
(7) Make 2G and 5G groove welds, on carbon steel pipe, using self-shielded electrodes.					
Gas-Shielded					
(8) Make fillet welds, all positions, on carbon steel pipe, using gas-shielded electrodes.					
(9) Make 2G and 5G groove welds, on carbon steel pipe, using gas-shielded electrodes.					
Self-Shielded and Gas-Shielded					
(10) Perform a combination workmanship qualification test on carbon steel pipe & plate.					

Course, Units and Learning Objectives	Performance		Date Completed	Instructor's Initials	Trainee's Initials
	PASS	FAIL			
Unit 4: GAS TUNGSTEN ARC WELDING (GTAW)					
Learning Objectives					
(1) Perform safety inspections of equipment and accessories.					
(2) Make minor external repairs to equipment and accessories.					
(3) Set up for gas tungsten arc welding operations on carbon steel, aluminum, and stainless steel.					
(4) Operate gas tungsten arc welding equipment.					
(5) Execute corrective actions to repair surface flaws on welds and base metals.					
(6) Make 3F and 4F fillet welds, on aluminum sheet.					
(7) Make 2G - 4G groove welds on aluminum sheet.					
(8) Make 4F fillet welds, on stainless steel sheet.					
(9) Make 3G - 4G groove welds on stainless steel sheet.					
(10) Make fillet welds, all positions, on carbon steel round tubing.					
(11) Make fillet welds, all positions, on aluminum round tubing.					
(12) Make fillet welds, all positions, on stainless round tubing.					
(13) Make 2G and 5G groove welds, on carbon steel round tubing.					
(14) Make 2G and 5G groove welds, on aluminum round tubing.					
(15) Make 2G and 5G groove welds, on stainless steel round tubing.					
(16) Perform combination workmanship qualification tests on plain carbon steel round tubing & sheet.					

Course, Units and Learning Objectives	Performance PASS	Performance FAIL	Date Completed	Instructor's Initials	Trainee's Initials
(17) Perform combination workmanship qualification tests on aluminum round tubing & sheet.					
(18) Perform combination workmanship qualification tests on stainless steel round tubing & sheet.					

TESTING and EVALUATION

	Test Attempts (per AWS QC11)	Score or Pass/Fail/ Substitution*	Date Completed	instructor's Initials	Trainee's Initials
Safety Pretest (100% required)					
SMAW Stainless Steel Workmanship					
SMAW Carbon Steel Pipe Workmanship					
GMAW Aluminum Plate Workmanship					
GMAW, GMAW-S Carbon Steel Plate/Pipe Workmanship					
FCAW-S, FCAW-G Carbon Steel Plate/Pipe Workmanship					
GTAW Carbon Steel Sheet/Round Tubing Workmanship:					
GTAW Aluminum Sheet/Round Tubing Workmanship:					
GTAW Plain Stainless Steel Sheet/Round Tubing Workmanship:					
Summative Closed Book Examination					
SMAW 6G Carbon Steel Pipe Performance Qualification					

*Substitution see next section

AWS QC 11 - Optional AWS QC7 Welder Performance Qualification Tests

(These welder performance qualification tests superceded the welder workmanship and performance qualification requirements of AWS QC11 as detailed in AWS EG3.0, Section 4 and were administered at an AWS QC4, Accredited Test Facility, within the guidelines of the AWS QC7, AWS Certified Welder Program and AWS QC7 Supplement G. Visual Examination and Bend Testing in accordance with AWS B2.1, Standard for Welding Procedure and Performance Qualification.)

	Test Attempts (per QC7, Sec. 7)	**Accept or Reject**	**Date Completed**	**instructor's Initials**	**Trainee's Initials**
3.3.6 COURSE F: ARC WELDING PRINCIPLES and PRACTICES					
3.3.6.1 Unit 1: SHIELDED METAL ARC WELDING (SMAW) **Learning Objectives**					
(9) 3G position, 3/8 inch thick stainless steel plate					
(9) 4G position, 3/8 inch thick stainless steel plate					
(11) 6G position, 6" or 8" Schedule 80 carbon steel pipe					
3.3.6.2 Unit 2: GAS METAL ARC WELDING (GMAW, GMAW-S) **Learning Objectives**					
(8) GMAW 3G position, 3/8 inch thick aluminum plate					
(8) GMAW 4G position, 3/8 inch thick aluminum plate					
(12) GMAW-S 2G position, 4" or 6" Schedule 40 carbon steel pipe					
(12) GMAW-S 5G position, 4" or 6" Schedule 40 carbon steel pipe					
(12) GMAW 1G position, 1 inch thick carbon steel plate					
3.3.6.3 Unit 3: FLUX CORED ARC WELDING (FCAW-S, FCAW-G **Learning Objectives**					
(10) FCAW-S 2G position, 6" or 8" Schedule 80 carbon steel pipe					
(10) FCAW-S 5G position, 6" or 8" Schedule 80 carbon steel pipe					
(10) FCAW-G 2G position, 6" or 8" Schedule 80 carbon steel pipe					
(10) FCAW-S 5G position, 6" or 8" Schedule 80 carbon steel pipe					

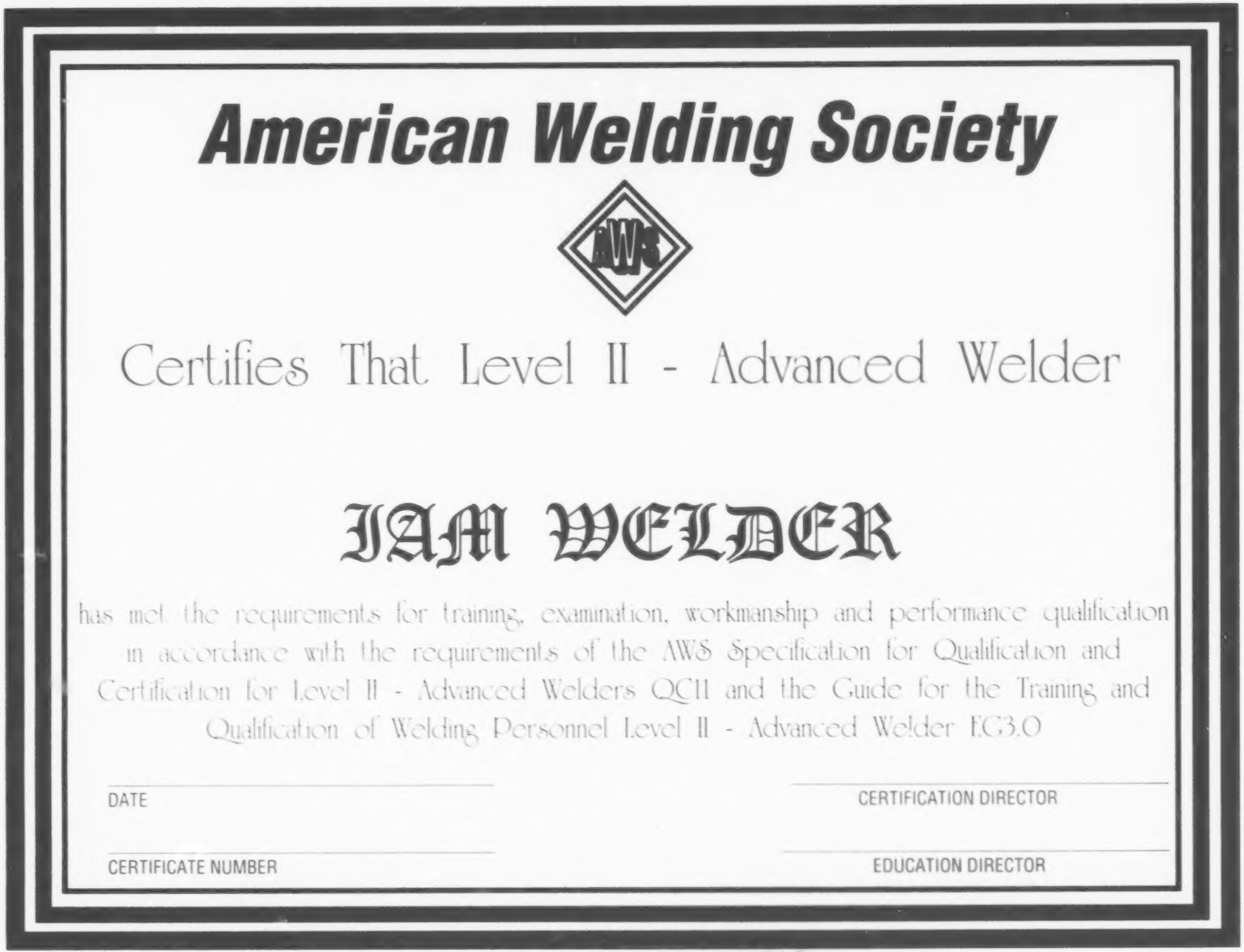
	Test Attempts (per QC7, Sec. 7)	Accept or Reject	Date Completed	instructor's Initials	Trainee's Initials
3.3.6.4 Unit 4: GAS TUNGSTEN ARC WELDING (GTAW) **Learning Objectives**					
(16) GTAW 2G position, 3" carbon steel round tubing					
(16) GTAW 5G position, 3" carbon steel round tubing					
(17) GTAW 2G position, 3" aluminum round tubing					
(17) GTAW 5G position, 3" aluminum round tubing					
(18) GTAW 2G position, 3" stainless steel round tubing					
(18) GTAW 5G position, 3" stainless steel round tubing					

Notes: ¹ Numbers in ( ) indicate the actual learning objective number of the workmanship or performance qualification test from AWS EG3.0 that was substituted for the AWS QC11 optional QC7 performance qualification examination.

INSTRUCTOR'S COMMENTS:

Welding Instructor

Date



American Welding Society

AWS

Certifies That Level II - Advanced Welder

IAM WELDER

has met the requirements for training, examination, workmanship and performance qualification in accordance with the requirements of the AWS Specification for Qualification and Certification for Level II - Advanced Welders QC11 and the Guide for the Training and Qualification of Welding Personnel Level II - Advanced Welder EG3.0

DATE

CERTIFICATION DIRECTOR

CERTIFICATE NUMBER

EDUCATION DIRECTOR

BEST COPY AVAILABLE

ANNEX G
Reference Materials

Safety

[12]ANSI Z49.1. . . . .*Safety in Welding, Cutting and Allied Processes*
[12]ANSI/AWS F2.2. . . . .*Lens Shade Selector Chart*

Welding Symbols

[12]A2.1. . . . .*Welding Symbols Chart*
[12]ANSI/AWS A2.4. . . . . . .*Standard Symbols, for Welding, Brazing and Nondestructive Examination*

Terms and Definitions

[12]ANSI/AWS A3.0. . . . . . .*Standard Welding Terms and Definitions*

Filler Metals and Electrodes

[12]ANSI/AWS A5.1. . . . . . .*Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.*
[12]ANSI/AWS A5.4. . . . . .*Specification for Corrosion-Resisting Chromium and Chromium Nickel Steel Covered Electrodes*
[12]ANSI/AWS A5.9. . . . . . .*Specification for Bare Stainless Steel Welding Electrodes and Rods*
[12]ANSI/AWS A5.10. . . . .*Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*
[12]ANSI/AWS A5.12. . . . .*Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting*
[12]ANSI/AWS A5.18. . . . . .*Specification for Carbon Steel Filler Metals for Gas-Shielded Arc Welding*
[12]ANSI/AWS A5.20. . . . . .*Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*

Welding Procedure and Performance Qualifications

[12]ANSI/AWS B2.1. . . . . . .*Standard for Welding Procedure and Performance Qualification*
[12]ANSI/AWS B2.1.001. . . .*Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel, (M-1/P-1, Group 1 or 2), 3/16 through 3/4 inch, in the As-Welded Condition, With Backing*
[12]ANSI/AWS B2.1.008. . .*Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Carbon Steel, (M-1, Group 1), 10 Gage through 18 Gage, in the As-Welded Condition, With or Without Backing*
[12]ANSI/AWS B2.1.009. . .*Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Austenitic Stainless Steel, (M-8/P8), 10 Gage through 18 Gage, in the As-Welded Condition, With or Without Backing*
[12]ANSI/AWS B2.1.015. . . .*Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Aluminum, (M-22/P-22), 10 Gage through 18 Gage, in the As-Welded Condition, With or Without Backing*

ANSI/AWS B2.1-1-016.	*Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1-1/2 inch Thick, E7018, As-Welded or PWHT Condition* ANSI/AWS B2.1.019, *Standard Welding Procedure Specification (WPS) for C02 Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E70T-1 and E71T-1, As-Welded Condition*
ANSI/AWS B2.1.020.	*Standard Welding Procedure Specification (WPS) for 75% Argon 25% CO2 Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E70T-1 and E71T-1, As-Welded or PWHT Condition*
ANSI/AWS B2.1-1-022.	*Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E6010, (Vertical Uphill) Followed By E7018, As-Welded or PWHT Condition*
ANSI/AWS B2.1-1-023.	*Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 through 1-1/2 inch Thick, As-Welded Condition*
ANSI/AWS B2.1-1-027.	*Standard Welding Procedure Specification (WPS) for Self-Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 3/4 inch thick, E71T-11, As-Welded Condition*
AWS-1-GMAW-S.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Short Circuit Transfer on Carbon Steel (M1/P1, Group 1 or 2), 3/16 through 3/4 inch Thick, in the As- Welded Condition*
AWS-2-GMAW.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Spray Transfer on Carbon Steel (M1/P1, Group 1 or 2), 3/16 through 3/4 inch Thick, As-Welded Condition*
AWS-5-GTAW.	*Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Aluminum, (M-23 or P-23), 10 Gage through 18 Gage, As-Welded Condition, With or Without Backing*
AWS2-1-SMAW.	*Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Austenitic Stainless Steel to Carbon Steel (M-1 to M-8 or P-8), 1/8 through 1/2 inch Thick, in the As-Welded Condition*
AWS2-1-GMAW.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Spray Transfer of Aluminum, (M-23/P-23/S-23), 1/8 through 3/4 inch Thick, in the As-Welded Condition*
AWS2-1.1-GMAW.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Spray Transfer of Aluminum, (M-22/P-22/S-22), 1/8 through 3/4 inch Thick, in the As-Welded Condition*
AWS2-2-GMAW.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Short Circuit Transfer of Carbon Steel (M-1/P-1/S-1, group 1 or 2), 1/8 inch through 3/8 inch Thick, in the As-Welded Condition*
AWS2-3-GMAW.	*Welding Procedure Specification (WPS) for Gas Metal Arc Welding – Spray Transfer of Carbon Steel (M-1/P-1/S-1, group 1 or 2), 1/8 inch through 1-1/2 inch Thick, in the As-Welded Condition*
AWS2-1-GTAW.	*Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Aluminum, (M-23/P-23/S-23), 10 through 18 Gauge Thick, in the As-Welded Condition*

[2]AWS2–1.1–GTAW.	*Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Aluminum, (M-22/P-22/S-22), 10 through 18 Gauge Thick, in the As-Welded Condition*

Welding Inspection and Testing

[1,2]ANSI/AWS B4.0.	*Standard Methods for Mechanical Testing of Welds*
[1,2]ANSI/AWS B 1.11.	*Guide for the Visual Inspection of Welds*
[1,2]WHB–2.8.	*Welding Handbook Volume One, Welding Technology*

Oxyfuel Gas Cutting Process

[1,2]ANSI/AWS C4.1–*G*.	*Oxygen Cutting Surface Roughness Gauge*
[1,2]ANSI/AWS C4.1–*WC*.	*Criteria for Describing Oxygen-Cut Surfaces*
[1,2]ANSI/AWS C4.2.	*Operator's Manual for Oxyfuel Gas Cutting*

Arc Welding and Cutting Processes

[1,2]ANSI/AWS C5.3.	*Recommended Practices for Air Carbon Arc Gouging and Cutting*
[1,2]ANSI/AWS C5.5.	*Recommended Practices for Gas Tungsten Arc Welding*
[1,2]ANSI/AWS C5.6.	*Recommended Practices for Gas Metal Arc Welding*
[1,2]WHB–2.8.	*Welding Handbook Volume Two, Welding Processes*

Base Metals (identification and Selection)

[1,2]WHB– 1.8.	*Welding Handbook Volume One, Welding Technology*

Program Implementation and Development

[1,2]AWS EG2.0.	*Guide for the Training and Qualification of Welding Personnel Entry Level Welder*
[2]AWS QC1.	*Standard for AWS Certification of Welding Inspectors*
[2]AWS QC4.	*Standard for Accreditation of Test Facilities for AWS Certified Welder Program*
[2]AWS QC5.	*Standard for Qualification and Certification of Welding Educators*
[2]AWS QC7.	*Standard for AWS Certified Welders*
[1,2]AWS QC10.	*Specification for Qualification and Certification for Entry Level Welder*
[2]AWS QC11.	*Specification for Qualification and Certification for Level II – Advanced Welder*
AWS–OTA.	*Occupational Task Analysis, Entry Level Welder*

Related Training Materials

AWS-ELW-DR.	*Entry Level Welder – Workmanship and Performance Qualification Drawings (full size 11 x 17 drawings)*
AWS-L2-DR.	*Level II – Advanced Welder – Workmanship and Performance Qualification Drawings (full size 11 x 17 drawings)*
AWS-WIT-T.	*Welding Inspection Technology*
AWS-WIT-I.	*Welding Inspection Technology Presentation Package*
AWS-WJT.	*Resource Guide to ... Joint-Weld Terminology and Standard Welding Symbols Interpretation (AWS home study course)*
AA-2.	*Aluminum Welder's Training Manual and Exercises*

Notes:

[1,2] **The specified resource material is part of the resource library provided to Participating Organizations for the AWS QC10 Entry Level Welder Program and also have a direct bearing on the AWS QC 11 Level II – Advanced Welder Program. These documents are not reissued when an existing participating organization upgrades to the AWS QC11 program.**

[1] **These documents are included as part of the resource library for the AWS QC10. Entry Level Welder Program. To be eligible for this library a training facility must be registered as an AWS QC10 Participating Organization.**

[2] **These documents are included as additional resource materials required for the AWS QC11 Level II – Advanced Welder Program. To be eligible for this upgrade to the resource library a training facility must be registered as an AWS QC11 Participating Organization.**